PALÆONTOGRAPHICAL SOCIETY.

VOL. XLIX.

# CRAG FORAMINIFERA.

PART II.

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# JURASSIC GASTEROPODA.

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## VOLUME XLIX.

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II. A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN COURSE OF PUBLICATION, AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS;

III. THE DATES OF ISSUE OF THE ANNUAL VOLUMES;

IV. A GENERAL SUMMARY, SHOWING THE NUMBER OF THE PAGES, PLATES, FIGURES, AND SPECIES IN EACH MONOGRAPH;

V. A STRATIGRAPHICAL LIST OF THE BRITISH FOSSILS FIGURED AND DESCRIBED IN THE YEARLY VOLUMES.

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# § I. CATALOGUE OF WORKS

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*Showing the* ORDER *of publication; the* YEARS *during which the Society has been in operation; and the* CONTENTS *of each yearly Volume.*

| | | | |
|---|---|---|---|
| Vol. I. | Issued for the Year | 1847 | The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates. |
| „ II. | „ | 1848 | The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates.<br>The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates. |
| „ III.* | „ | 1849 | The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates.<br>The Permian Fossils, by Prof. Wm. King, 29 plates.<br>The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates.<br>The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime, 11 plates. |
| „ IV. | „ | 1850 | The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood, 12 plates.<br>The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates.<br>The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates. |

* The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils;' the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

## CATALOGUE OF WORKS—Continued.

| | | | |
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| Vol. V. | Issued for the Year 1851 | | The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates.<br>The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime, 19 plates.<br>The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates. |
| „ VI. | „ | 1852 | The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime, 16 plates.<br>The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson, 2 plates.<br>The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates.<br>The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson, 5 plates.<br>The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates.<br>The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates. |
| „ VII. | „ | 1853 | The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime, 10 plates.<br>The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates.<br>The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates.<br>The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates.<br>The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates.<br>The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates. |
| „ VIII.* | „ | 1854 | The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous, with Appendix and Index to Vol. I, by Mr. Davidson, 8 plates.<br>The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates.<br>The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates.<br>The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates.<br>The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates.<br>The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates.<br>The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates. |
| „ IX.† | „ | 1855 | The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates.<br>The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates.<br>The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards, 4 plates.<br>The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates.<br>The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates.<br>The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright, 10 plates. |
| „ X. | „ | 1856 | The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright, 12 plates.<br>The Fossil Crustacea, Part I, London Clay, by Prof. Bell, 11 plates.<br>The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson, 4 plates.<br>The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates.<br>The Reptilia of the Wealden Formations, Part IV (Supplement No. 1), by Prof. Owen, 11 plates.<br>The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen, 2 plates. |
| „ XI. | „ | 1857 | The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright, 14 plates.<br>The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson, 8 plates.<br>The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen, 4 plates.<br>The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen, 8 plates.<br>The Polyzoa of the Crag, by Prof. Busk, 22 plates. |
| „ XII. | „ | 1858 | The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright, 7 plates.<br>The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards, 6 plates.<br>The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen, 7 plates.<br>The Reptilia of the Purbeck Limestones, by Prof. Owen, 1 plate.<br>The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous, by Mr. Davidson, 10 plates. |
| „ XIII. | „ | 1859 | The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates.<br>The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen, 6 plates.<br>The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen, 1 plate.<br>The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates. |

* This Vol. is marked on the outside 1855.
† This Vol. is marked on the outside 1856.

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| Vol. XXXIII.* | Issued for the Year 1879 | The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates.<br>Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates.<br>The Fossil Trigoniæ, No. V (*Conclusion*), by Dr. Lycett, 1 plate.<br>The Lias Ammonites, Part II, by Dr. Wright, 10 plates.<br>Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen, 4 plates.<br>The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams, 10 plates. |
| ,, XXXIV.* | ,, 1880 | The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates.<br>The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates.<br>Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson, 8 plates.<br>The Lias Ammonites, Part III, by Dr. Wright, 22 plates.<br>The Reptilia of the London Clay, Vol. II, Part I (Chelone) by Prof. Owen, 2 plates. |
| ,, XXXV.* | ,, 1881 | The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright, 6 plates.<br>Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson, 5 plates.<br>The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett.<br>The Lias Ammonites, Part IV, by Dr. Wright, 10 plates.<br>The Reptilia of the Liassic Formations, Part III (*Conclusion*), by Prof. Owen, 13 plates.<br>The Fossil Elephants (E. primigenius and E. meridionalis), Part III (*Conclusion*), by Prof. Leith Adams, 13 plates. |
| .. XXXVI.* | .. 1882 | The Eocene Flora, Vol. I, Part III (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates.<br>Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate.<br>The Fossil Echinodermata, Cret., Vol. I, Part X (*Conclusion*), by Dr. Wright, 5 plates.<br>Supplement to the Fossil Brachiopoda, Vol. IV, Part V (*Conclusion*), by Dr. Davidson.<br>Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson, 7 plates.<br>The Lias Ammonites, Part V, by Dr. Wright, 22 plates. |
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| .. XXXVIII.* | ,, 1884 | The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner, 11 plates.<br>The Carboniferous Entomostraca, Part I, No. 2 (*Conclusion*), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady, 2 plates.<br>The Carboniferous Trilobites, Part II, by Dr. H. Woodward, 4 plates.<br>Supplement to the Fossil Brachiopoda, Vol. V, Part III (*Conclusion*), by Dr. Davidson, 4 plates.<br>The Lias Ammonites, Part VII, by Dr. Wright, 10 plates. |
| ,, XXXIX.* | ,, 1885 | The Eocene Flora, Vol. II, Part III (*Conclusion*), by Mr. J. S. Gardner, 7 plates.<br>The Stromatoporoids, Part I, by Prof. Alleyne Nicholson, 11 plates.<br>The Fossil Brachiopoda (Bibliography), Vol. VI (*Conclusion*), by the late Dr. Davidson and Mr. W. H. Dalton.<br>The Lias Ammonites, Part VIII (*Conclusion*), by the late Dr. Wright, 1 plate. |
| ,, XL.* | ,, 1886 | The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson, 15 plates.<br>The Fossil Sponges, Part I, by Dr. G. J. Hinde, 8 plates.<br>The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston.<br>The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman, 6 plates.<br>The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins, 7 plates. |
| . XLI.* | ,, 1887 | The Fossil Sponges, Part II, by Dr. G. J. Hinde, 1 plate.<br>The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward, 12 plates.<br>The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston, 6 plates.<br>The Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman, 8 plates. |

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| Vol. XLII.* | Issued for the Year 1888 | The Stromatoporoids, Part II, by Prof. Alleyne Nicholson, 8 plates.<br>The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn, 3 plates.<br>The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston, 5 plates.<br>The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman, 10 plates.<br>The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne, 4 plates.<br>Title-pages to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag. |
| „ XLIII.* | „ 1889 | The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde, 4 plates.<br>The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston, 5 plates.<br>The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman, 13 plates.<br>The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne, 12 plates. |
| „ XLIV.* | „ 1890 | The Stromatoporoids, Part III, by Prof. Alleyne Nicholson, 6 plates.<br>The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen, 8 plates.<br>The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman, 8 plates.<br>The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne, 9 plates.<br>Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan. |
| „ XLV.* | „ 1891 | The Jurassic Gasteropoda, Part I, No. 5, by Mr. W. H. Hudleston, 4 plates.<br>The Inferior Oolite Ammonites, Part VI, by Mr. S. S. Buckman, 12 plates.<br>The Devonian Fauna of the South of England, Part IV (*Conclusion of* Vol. I), 7 plates.<br>„ „ Vol. II, Part I, by the Rev. G. F. Whidborne, 5 plates. |
| „ XLVI.* | „ 1892 | The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson, 4 plates.<br>The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward, 5 plates.<br>The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston, 6 plates.<br>The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman, 20 plates.<br>The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne, 5 plates. |
| „ XLVII.* | „ 1893 | The Fossil Sponges, Part III, by Dr. G. J. Hinde, 10 plates.<br>The Fossil Echinodermata, Cretaceous, Vol. II, Part II (Asteroidea), by Mr. W. Percy Sladen, 8 plates.<br>The Inferior Oolite Ammonites, Part VIII, by Mr. S. S. Buckman, 16 plates.<br>The Devonian Fauna of the South of England, Vol. II, Part III, by the Rev. G. F. Whidborne, 7 plates. |
| „ XLVIII.* | „ 1894 | The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston, 6 plates.<br>Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind, 11 plates.<br>The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman, 11 plates.<br>The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair, 4 plates. |
| „ XLIX.* | „ 1895 | The Crag Foraminifera, Part II, by Prof. T. R. Jones, 3 plates.<br>The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston, 8 plates.<br>Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind, 9 plates.<br>The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne, 7 plates. |

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

# § II. LIST OF MONOGRAPHS

## Completed, in course of Publication, and in Preparation.

1. MONOGRAPHS which have been COMPLETED, and which may be bound as separate Volumes, with directions for the BINDING :—

The Morphology and Histology of Stigmaria ficoides by Prof. W. C. Williamson. (*Complete with Title-page and Index in the Volume for the year* 1886.)

The Eocene Flora, Vol. I (Filices), by Mr. J. S. Gardner and Baron Ettingshausen. (*Complete in the Volumes for the years* 1879, 1880, *and* 1882. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1882.)

The Eocene Flora, Vol. II (Gymnospermæ), by Mr. J. S. Gardner. (*Complete in the Volumes for the years* 1883, 1884, *and* 1885. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1885.)

The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady. (*Complete in the Volume for the year* 1876.)

The Stromatoporoids, by Prof. Alleyne Nicholson. (*Complete in the Volumes for the years* 1885, 1888, 1890, and 1892. *The Title-page, Index, and directions for binding will be found in the Volume for the year* 1892.)

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime. (*Complete in the Volumes for the years* 1849, 1851, 1852, 1853, *and* 1854. *The Title-page and Index, with corrected explanations of Plates XVII and XVIII, will be found in the Volume for the year* 1854.)

Supplement to the Tertiary, Cretaceous, Liassic, and Oolitic Corals, by Prof. Martin Duncan. (*Complete in the Volumes for the years* 1865, 1866, 1867, 1868, 1869, 1872, *and* 1890. *The Title-page, with directions for binding, will be found in the Volume for the year* 1890.)

The Polyzoa of the Crag, by Mr. G. Busk. (*Complete with Title-page and Index in the Volume for the year* 1857.)

The Tertiary Echinodermata, by Professor Forbes. (*Complete with Title-page in the Volume for the year* 1852.)

The Fossil Cirripedes, by Mr. C. Darwin. (*Complete in the Volumes for the years* 1851, 1854, *and* 1858. *The Title-page will be found in the Volume for the year* 1854, *and the Index in the Volume for the year* 1858.

The Post-Tertiary Entomostraca, by Mr. G. S. Brady, the Rev. H. W. Crosskey, and Mr. D. Robertson. (*Complete, with Title-page and Index, in the Volume for the year* 1874.)

The Tertiary Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1855.)

The Cretaceous Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1849.)

Supplement to the Cretaceous Entomostraca, by Prof. T. Rupert Jones and Dr. G. J. Hinde. (*Complete, with Title-page and Index, in the Volume for the year* 1889.)

The Carboniferous Entomostraca, Part I (Cypridinadæ and their allies), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady. (*Complete in the volumes for the years* 1874 *and* 1884. *The Title-page and Index will be found in the Volume for the year* 1884.)

The Fossil Estheriæ, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1860.)

The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. (*Complete in the Volumes for the years* 1862, 1863, 1864, 1866, *and* 1883. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Fossil Merostomata, by Dr. H. Woodward. (*Complete in the Volumes for the years* 1865, 1868, 1871, 1872, *and* 1878. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1878.)

The Fossil Brachiopoda (Tertiary, Cretaceous, Oolitic, and Liassic), Vol. I, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1850, 1852, 1853, *and* 1854. *The Index will be found in the Volume for the year* 1854, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Permian and Carboniferous), Vol. II, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1856, 1857, 1858, 1859, *and* 1860. *The Index will be found in the Volume for the year* 1860, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Devonian and Silurian), Vol. III, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1862, 1863, 1865, 1866, 1868, *and* 1870. *The Title-page and Index will be found in the Volume for the year* 1870.)

The Fossil Brachiopoda, Vol. IV, by Dr. T. Davidson. Supplements: Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous. (*Complete in the Volumes for the years* 1873, 1876, 1878, 1880, 1881, *and* 1882. *The Title-page and Index, with directions for the binding will be found in the Volume for the year* 1882.)

The Fossil Brachiopoda, Vol. V, by Dr. T. Davidson. Supplements: Devonian and Silurian. Appendix to Supplements, General Summary, Catalogue and Index of the British Species. (*Complete in the Volumes for the years* 1882, 1883, *and* 1884. *The Title-page, with directions for the binding will be found in the Volume for the year* 1884.)

The Fossil Brachiopoda, Vol. VI, by Dr. T. Davidson and Mr. W. H. Dalton. Bibliography. (*Complete in the Volume for the year* 1885.)

The Eocene Bivalves, Vol. I, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volumes for the years* 1859, 1862, *and* 1870. *The directions for the binding will be found in the Volume for the year* 1870.)

Supplement to the Eocene Bivalves, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1877.)

The Eocene Cephalopoda and Univalves, Vol. I, by Mr. F. E. Edwards and Mr. S. V. Wood. (*Complete in the Volumes for the years* 1848, 1852, 1854, 1855, 1858, *and* 1877. *The Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1877.)

The Mollusca of the Crag, Vol. I, Univalves, by Mr. S. V. Wood. (*The Text, Plates, and Index, will be found in the Volume for the year* 1847, *and the Title-page will be found in the Volume for the year* 1855.)

The Mollusca of the Crag, Vol. II, Bivalves, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1850, 1853, 1855, 1858, *and* 1873. *The Title-page will be found in the Volume for the year* 1873, *and the Index will be found in the Volume for the year* 1855, *and a Note in the Volume for the year* 1858).

The Mollusca of the Crag, Vol. III, Supplement, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1871 *and* 1873. *The Title-page and Index will be found in the Volume for the year* 1873.)

Second Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1879.)

Third Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1882.)

The Great Oolite Mollusca, by Professor Morris and Dr. Lycett. (*Complete in the Volumes for the years* 1850, 1853, *and* 1854. *The Title-page and Index will be found in the Volume for the year* 1854.)

The Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1872, 1874, 1875, 1877, *and* 1879. *The directions for the binding will be found in the Volume for the year* 1879.)

Supplement to the Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1881 *and* 1883. *The Title-page, Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Oolitic Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1855, 1856, 1857, 1858, *and* 1878. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1878.)

The Oolitic Echinodermata, Vol. II, Asteroidea, by Dr. Wright. (*Complete in the Volumes for the years* 1861, 1864, *and* 1880. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1880).

The Cretaceous Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, *and* 1882. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1882.)

The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe. (*Complete in the Volumes for the years* 1853, 1854, *and* 1855, *but wants Title-page and Index.*)

The Lias Ammonites, by Dr. Wright. (*Complete in the Volumes for the years* 1878, 1879, 1880, 1881, 1882, 1883, 1884, *and* 1885. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1885.)

The Fossils of the Permian Formation, by Professor King. *Complete, with Title-page and Index, in the Volume for the year* 1849. *Corrected explanations of Plates XXVIII and XXVIII* will be found in the Volume for the year* 1854.)

The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), Vol. I, by Professors Owen and Bell. (*Complete in the Volumes for the years* 1848, 1849, 1856, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.) Part I of Vol. II, containing Chelone gigas (*to be found in the Volume for the year* 1880), can be added.

The Reptilia of the Cretaceous Formations, by Prof. Owen. (*Complete in the Volumes for the years* 1851, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations, by Professor Owen. (*Complete in the Volumes for the years* 1853, 1854, 1855, 1856, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), by Professor Owen. (*Complete in the Volumes for the years* 1871, 1873, 1876, 1878, 1879, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Kimmeridge Clay Formation, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1868, and 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Liassic Formations, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1863, 1869, *and* 1881. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1881.)

The Reptilia of the Mesozoic Formations, by Professor Owen. (*Complete in the Volume for the years* 1873, 1875, 1877, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Red Crag Cetacea, by Professor Owen. (*Complete in the Volumes for the years* 1869 *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Fossil Mammalia of the Mesozoic Formations, by Professor Owen. (*Complete, with Title-page and Table of Contents, in the Volume for the year* 1870.)

The Fossil Elephants, by Professor Leith Adams. (*Complete in the Volumes for the years* 1877, 1879, *and* 1881. *Directions for the binding, Title-page, and Index will be found in the Volume for the year* 1881.)

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2. MONOGRAPHS in course of PUBLICATION :*—

The Fossil Sponges, by Dr. G. J. Hinde.

The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.†

The Jurassic Gasteropoda, by Mr. W. H. Hudleston.

Carbonicola, Anthracomya, and Naiadites, by Dr. Wheelton Hind.

The Palæozoic Phyllopoda, by Prof. T. Rupert Jones and Dr. H. Woodward.

The Trilobites, by Dr. H. Woodward.

The Inferior Oolite Ammonites, by Mr. S. S. Buckman.

The Belemnites, by Professor Phillips.‡

The Sirenoid and Crossopterygian Ganoids, by Professor Miall.

The Fishes of the Carboniferous Formation, by Dr. R. H. Traquair.

The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, and Professor Traquair.

The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.

The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

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3. MONOGRAPHS which are promised or are in course of PREPARATION :*—

The Fossil Cycadeæ, by Mr. A. C. Seward.

The Graptolites, by Prof. Lapworth.

The Carboniferous Entomostraca, Part II (Leperditiadæ), by Prof. T. Rupert Jones.

The Wealden, Purbeck, and Jurassic Entomostraca, by Prof. T. R. Jones.

The Purbeck Mollusca, by Mr. R. Etheridge.

The Rhætic Mollusca, by Mr. R. Etheridge.

The Cambrian Fossils, by Dr. H. Hicks.

The Silurian Fish Bed, by Dr. Harley.

The Fossils of the Budleigh Salterton Pebble Bed, by the Rev. G. F. Whidborne.

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* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

† Will be finished by Prof. T. Rupert Jones.

‡ Unfinished through the death of the Author, but will be continued by Mr. G. C. Crick.

## § III. Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Volume | I | for | 1847 | was | issued | to | the Members, | March, 1848. |
| ,, | II | ,, | 1848 | ,, | ,, | ,, | ,, | July, 1849. |
| ,, | III | ,, | 1849 | ,, | ,, | ,, | ,, | August, 1850. |
| ,, | IV | ,, | 1850 | ,, | ,, | ,, | ,, | June, 1851. |
| ,, | V | ,, | 1851 | ,, | ,, | ,, | ,, | June, 1851. |
| ,, | VI | ,, | 1852 | ,, | ,, | ,, | ,, | August, 1852. |
| ,, | VII | ,, | 1853 | ,, | ,, | ,, | ,, | December, 1853. |
| ,, | VIII | ,, | 1854 | ,, | ,, | ,, | ,, | May, 1855. |
| ,, | IX | ,, | 1855 | ,, | ,, | ,, | ,, | February, 1857. |
| ,, | X | ,, | 1856 | ,, | ,, | ,, | ,, | April, 1858. |
| ,, | XI | ,, | 1857 | ,, | ,, | ,, | ,, | November, 1859. |
| ,, | XII | ,, | 1858 | ,, | ,, | ,, | ,, | March, 1861. |
| ,, | XIII | ,, | 1859 | ,, | ,, | ,, | ,, | December, 1861. |
| ,, | XIV | ,, | 1860 | ,, | ,, | ,, | ,, | May, 1863. |
| ,, | XV | ,, | 1861 | ,, | ,, | ,, | ,, | May, 1863. |
| ,, | XVI | ,, | 1862 | ,, | ,, | ,, | ,, | August, 1864. |
| ,, | XVII | ,, | 1863 | ,, | ,, | ,, | ,, | June, 1865. |
| ,, | XVIII | ,, | 1864 | ,, | ,, | ,, | ,, | April, 1866. |
| ,, | XIX | ,, | 1865 | ,, | ,, | ,, | ,, | December, 1866. |
| ,, | XX | ,, | 1866 | ,, | ,, | ,, | ,, | June, 1867. |
| ,, | XXI | ,, | 1867 | ,, | ,, | ,, | ,, | June, 1868. |
| ,, | XXII | ,, | 1868 | ,, | ,, | ,, | ,, | February, 1869. |
| ,, | XXIII | ,, | 1869 | ,, | ,, | ,, | ,, | January, 1870. |
| ,, | XXIV | ,, | 1870 | ,, | ,, | ,, | ,, | January, 1871. |
| ,, | XXV | ,, | 1871 | ,, | ,, | ,, | ,, | June, 1872. |
| ,, | XXVI | ,, | 1872 | ,, | ,, | ,, | ,, | October, 1872. |
| ,, | XXVII | ,, | 1873 | ,, | ,, | ,, | ,, | February, 1874. |
| ,, | XXVIII | ,, | 1874 | ,, | ,, | ,, | ,, | July, 1874. |
| ,, | XXIX | ,, | 1875 | ,, | ,, | ,, | ,, | December, 1875. |
| ,, | XXX | ,, | 1876 | ,, | ,, | ,, | ,, | December, 1876. |
| ,, | XXXI | ,, | 1877 | ,, | ,, | ,, | ,, | February, 1877. |
| ,, | XXXII | ,, | 1878 | ,, | ,, | ,, | ,, | March, 1878. |
| ,, | XXXIII | ,, | 1879 | ,, | ,, | ,, | ,, | May, 1879. |
| ,, | XXXIV | ,, | 1880 | ,, | ,, | ,, | ,, | May, 1880. |
| ,, | XXXV | ,, | 1881 | ,, | ,, | ,, | ,, | May, 1881. |
| ,, | XXXVI | ,, | 1882 | ,, | ,, | ,, | ,, | June, 1882. |
| ,, | XXXVII | ,, | 1883 | ,, | ,, | ,, | ,, | October, 1883. |
| ,, | XXXVIII | ,, | 1884 | ,, | ,, | ,, | ,, | December, 1884. |
| ,, | XXXIX | ,, | 1885 | ,, | ,, | ,, | ,, | January, 1886. |
| ,, | XL | ,, | 1886 | ,, | ,, | ,, | ,, | March, 1887. |
| ,, | XLI | ,, | 1887 | ,, | ,, | ,, | ,, | January, 1888. |
| ,, | XLII | ,, | 1888 | ,, | ,, | ,, | ,, | March, 1889. |
| ,, | XLIII | ,, | 1889 | ,, | ,, | ,, | ,, | March, 1890. |
| ,, | XLIV | ,, | 1890 | ,, | ,, | ,, | ,, | April, 1891. |
| ,, | XLV | ,, | 1891 | ,, | ,, | ,, | ,, | February, 1892. |
| ,, | XLVI | ,, | 1892 | ,, | ,, | ,, | ,, | November, 1892. |
| ,, | XLVII | ,, | 1893 | ,, | ,, | ,, | ,, | December, 1893. |
| ,, | XLVIII | ,, | 1894 | ,, | ,, | ,, | ,, | November, 1894. |
| ,, | XLIX | ,, | 1895 | ,, | ,, | ,, | ,, | October, 1895. |

§ IV. SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* OCTOBER, 1895): *showing in the* FIRST *column whether each Monograph hitherto published be* complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph (as a guide to binding the same); and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

| I. SUBJECT OF MONOGRAPH. | II. Dates of the Years *for which* the volume containing the Monograph was issued. | III *m*. Dates of the Years *in which* the Monograph was published. | IV. No. of Pages of Letterpress in each Monograph. | V. No. of Plates in each Monograph. | VI. No. of Lithographed Figures and of Woodcuts. | VII. No. of Species described in the Text. |
|---|---|---|---|---|---|---|
| The Morphology and Histology of Stigmaria ficoides, by Prof. W. C. Williamson, COMPLETE ..... | 1886 | 1887 | 66 | 15 | 91 | 1 |
| The Eocene Flora, by Mr. J. S. Gardner and Baron Ettingshausen. Vol. I, COMPLETE ..... | 1879, 1880, 1882 | 1879, 1880, 1882 | 87 | 13 | 151 | 23 |
| ,, ,, by Mr. J. S. Gardner. Vol. II, COMPLETE ..... | 1883, 1884, 1885 | 1883, 1884, 1886 | 159 | 27 | 400 | 31 |
| The Flora of the Carboniferous Strata, by Mr. E. W. Binney, *in course of completion* .. ..... | 1867, 1870, 1871, 1875 | 1868, 1871, 1872, 1875 | 147 | 24 | 141 | 16 |
| The Fossil Sponges, by Dr. G. J. Hinde, *in course of completion*..... | 1886, 1887, 1893 | 1887, 1888, 1893 | 254 | 19 | 602 | 106 |
| The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, *in course of completion* ..... | 1865, 1895 | 1866, 1895 | 216 | 7 | 380 | 69 |
| The Carboniferous and Permian Foraminifera, by Mr. H. B. Brady, COMPLETE..... | 1876 | 1876 | 166 | 12 | 266 | 62 |
| The Stromatoporoids, by Prof. Alleyne Nicholson, COMPLETE ..... | 1885, 1888, 1890, 1892 | 1886, 1889, 1891, 1892 | 237 | 29 | 415 | 44 |
| The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, COMPLETE (*k*) ..... | 1849, 1851, 1852, 1853, 1854 | 1850, 1851, 1852, 1853, 1855 | 406 | 72 | 800 | 319*g* |
| Supplement to the Tertiary, Cretaceous, Oolitic, and Liassic Corals, by Prof. Duncan, COMPLETE | 1865, 1866, 1867, 1868, 1869, 1872, 1890 | 1866, 1867, 1868, 1869, 1870, 1872, 1891 | 232 | 49 | 797 | 149 |
| The Polyzoa of the Crag, by Mr. G. Busk, COMPLETE ..... | 1857 | 1859 | 145 | 22 | 641 | 122 |
| The Tertiary Echinodermata, by Prof. Forbes, COMPLETE ..... | 1852 | 1852 | 39 | 4 | 144 | 44 |
| The Oolitic Echinodermata, by Dr. Wright. Vol. I, COMPLETE (*l*) ..... | 1855, 1856, 1857, 1858, 1878 | 1857, 1858, 1859, 1861, 1878 | 491 | 43 | 724 | 120*h* |
| ,, ,, Vol. II, COMPLETE ..... | 1861, 1864, 1880 | 1863, 1866, 1880 | 207 | 22 | 232 | 35 |
| The Cretaceous Echinodermata, by Dr. Wright. Vol. I, COMPLETE..... | 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882 | 1864, 1868, 1870, 1871, 1872, 1874, 1875, 1878, 1881, 1882 | 390 | 87 | 1119 | 113 |
| ,, ,, by Mr. W. Percy Sladen. Vol. II, *in course of completion* ..... | 1890, 1893 | 1891, 1893 | 66 | 16 | 173 | 19 |
| The Fossil Cirripedes, by Mr. C. Darwin, COMPLETE ..... ..... | 1851, 1854, 1858*a* | 1851, 1855, 1861 | 137 | 7 | 320 | 54 |
| The Fossil Merostomata, by Dr. H. Woodward, COMPLETE ..... ..... | 1865, 1868, 1871, 1872, 1878 | 1866, 1869, 1872, 1872, 1878 | 265 | 36 | 365 | 51 |
| The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, COMPLETE ..... ..... | 1874 | 1874 | 237 | 16 | 515 | 134 |
| The Tertiary Entomostraca, by Prof. Rupert Jones, COMPLETE ..... | 1855 | 1857 | 74 | 6 | 233 | 56 |
| ,, ,, ,, and Mr. C. D. Sherborn (Supplement), COMPLETE | 1888 | 1889 | 55 | 3 | 134 | 48 |
| The Cretaceous Entomostraca, by Prof. Rupert Jones, COMPLETE ..... | 1849 | 1850 | 41 | 7 | 176 | 31 |
| ,, ,, ,, and Dr. G. J. Hinde (Supplement) ..... | 1889 | 1890 | 78 | 4 | 258 | 46 |
| The Carboniferous Entomostraca, by Prof. Rupert Jones and Messrs. J. W. Kirkby and Prof. G. S. Brady. Part I, COMPLETE..... | 1874, 1884 | 1874, 1884 | 95 | 7 | 374 | 81 |
| The Fossil Estheriæ, by Prof. Rupert Jones, COMPLETE ..... | 1860 | 1863 | 139 | 5 | 158 | 19*i* |
| | | CARRIED FORWARD... | 4429 | 552 | 9609 | 1793 |

| SUBJECT OF MONOGRAPH. | II. Dates of the Years *for which* the volume containing the Monograph was issued. | III. Dates of the Years *in which* the Monograph was published. | IV. No. of Pages of Letterpress in each Monograph. | V. No. of Plates in each Monograph. | VI. No. of Lithographed Figures and of Woodcuts. | VII. No. of Species described in the Text. |
|---|---|---|---|---|---|---|
| | | BROUGHT FORWARD... | 4129 | 552 | 9609 | 1793 |
| The Palæozoic Phyllopoda, by Prof. Rupert Jones and Dr. H. Woodward, *in course of completion* | 1887, 1892 | 1888, 1892 | 124 | 17 | 226 | 72 |
| The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter, COMPLETE | 1862, 1863, 1864, 1866, 1883 | 1864, 1865, 1866, 1867, 1883 | 224 | 31 | 703 | 111 |
| The Carboniferous Trilobites, by Dr. H. Woodward, COMPLETE | 1883, 1884 | 1883, 1884 | 86 | 10 | 148 | 31 |
| The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell | 1856, 1860 | 1858, 1863 | 88 | 22 | 215 | 50 |
| The Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous, Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, COMPLETE | 1850, 1852, 1853, 1854 | 1851, 1852, 1853, 1855 | 409 | 12 | 1855 | 160 |
| " " Vol. II. The Permian and Carboniferous Brachiopoda, COMPLETE | 1856*d*, 1857, 1858, 1859, 1860 | 1858, 1859, 1861, 1861, 1863 | 331 | 59 | 1909 | 157 |
| " " Vol. III. The Devonian and Silurian Brachiopoda, COMPLETE | 1862, 1863, 1865, 1866, 1868, 1870 | 1864, 1865, 1866, 1867, 1869, 1871 | 528 | 70 | 2766 | 321 |
| " " Vol. IV. Supplements, Tertiary to Carboniferous, COMPLETE | 1873, 1876, 1878, 1880, 1881, 1882 | 1874, 1876, 1878, 1880, 1881, 1882 | 383 | 12 | 1664 | 215 |
| " " Vol. V. Supplements, Devonian and Silurian, COMPLETE | 1882, 1883, 1884 | 1882, 1883, 1884 | 476 | 21 | 1135 | 116 |
| " " Vol. VI. Bibliography, COMPLETE | 1885 | 1886 | 163 | — | — | — |
| The Fossil Trigoniæ, by Dr. Lycett, COMPLETE | 1872, 1874, 1875, 1877, 1879 | 1872, 1874, 1875, 1877, 1879 | 246 | 41 | 446 | 115 |
| Supplement to the Fossil Trigoniæ, by Dr. Lycett, COMPLETE | 1881, 1883 | 1881, 1883 | 19 | 4 | 53 | 9*b* |
| The Mollusca of the Crag, by Mr. S. V. Wood. Vol. I. (Univalves), COMPLETE | 1847, 1855*b* | 1848, 1857 | 216 | 21 | 581 | 244 |
| Vol. II. (Bivalves), COMPLETE | 1850, 1853, 1855, 1858*c* | 1851, 1853, 1857, 1861 | 344 | 31 | 691 | 253 |
| Supplements to the Crag Mollusca, No. I, II, and III, by Mr. S. V. Wood, COMPLETE | 1871, 1873, 1879, 1882 | 1872, 1874, 1879, 1882 | 346 | 19 | 546 | 245 |
| The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood. Vol. I, COMPLETE | 1848, 1852, 1854, 1855, 1858, 1877 | 1849, 1852, 1855, 1857, 1861, 1877 | 361 | 31 | 625 | 275 |
| The Eocene Mollusca, Bivalves, by Mr. S. V. Wood. Vol. I, COMPLETE | 1859, 1862, 1870 | 1861, 1864, 1871 | 182 | 25 | 531 | 194 |
| Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves). Vol. I, COMPLETE | 1877 | 1877 | 24 | 2 | 66 | 30 |
| The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, COMPLETE | 1850, 1853, 1854 | 1851, 1853, 1855 | 282 | 30 | 846 | 419 |
| " " " Supplement by Dr. Lycett, COMPLETE | 1861 | 1863 | 129 | 15 | 337 | 194 |
| The Jurassic Gasteropoda, by Mr. W. H. Hudleston, *in course of completion* | 1886, 1887, 1888, 1889, 1891, 1892, 1894, 1895 | 1887, 1888, 1889, 1890, 1892, 1892, 1894, 1895 | 436 | 40 | 1161 | 386 |
| Carbonicola, Anthracomya, and Naiadites, by Dr. Wheelton Hind, *in course of completion* | 1894, 1895 | 1894, 1895 | 170 | 20 | 687 | 44 |
| The Inferior Oolite Ammonites, by Mr. S. S. Buckman, *in course of completion* | 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894 | 1887, 1888, 1889, 1890, 1891, 1892, 1892, 1893, 1894 | 456 | 104 | 1137 | 168 |
| The Liassic Ammonites, by Dr. Wright, COMPLETE | 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885 | 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1886 | 503 | 91 | 726 | 107 |
| | | CARRIED FORWARD... | 10955 | 1343 | 28663 | 5712 |

| I. SUBJECT OF MONOGRAPH. | II. Dates of the Years *for which* the volume containing the Monograph was issued. | III *m*. Dates of the Years *in which* the Monograph was published. | IV. No. of Pages of Letterpress in each Monograph. | V. No. of Plates in each Monograph. | VI. No. of Lithographed Figures and of Woodcuts. | VII. No. of Species described in the Text. |
|---|---|---|---|---|---|---|
| BROUGHT FORWARD... | | | 10955 | 1343 | 28663 | 5712 |
| The Belemnites, by Prof. Phillips, *in course of completion* | 1863, 1864, 1866, 1868, 1869 | 1865, 1866, 1867, 1869, 1870 | 128 | 36 | 622 | 69 |
| The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE | 1853, 1854, 1855 | 1853, 1855, 1857 | 67 | 27 | 319 | 79 |
| The Fossils of the Permian Formation, by Prof. King, COMPLETE | 1849, 1854*e* | 1850, 1855 | 287 | 29 | 511 | 138 |
| The Fauna of the Devonian Formation, by the Rev. G. F. Whidborne, Vol. I, COMPLETE | 1888, 1889, 1890, 1891 | 1889, 1890, 1891, 1892 | 346 | 32 | 770 | 206 |
| ,, ,, ,, Vol. II, *in course of completion* | 1891, 1892, 1893, 1895 | 1892, 1892, 1893, 1895 | 212 | 24 | 489 | 176 |
| The Sirenoid Ganoids, by Prof. Miall, *in course of completion* | 1878 | 1878 | 32 | 6 | 61 | 6 |
| The Fishes of the Carboniferous Formation, by Dr. Traquair, *in course of completion* | 1877 | 1877 | 60 | 7 | 58 | 5 |
| The Fishes of the Old Red Sandstone, by Messrs. J. Powrie, E. Ray Lankester, and Dr. Traquair, *in course of completion* | 1867, 1869, 1894 | 1868, 1870, 1894 | 90 | 18 | 232 | 22 |
| The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, Vol. I, COMPLETE ‡ | 1848, 1849, 1856*f* | 1849, 1850, 1859 | 150 | 58 | 304 | 39 |
| ,, ,, Vol. II, Part I, by Prof. Owen, COMPLETE | 1880 | 1880 | 4 | 2 | 4 | 1 |
| The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE‡ | 1851, 1857, 1858, 1862 | 1851, 1859, 1861, 1864 | 184 | 59 | 519 | 26 |
| The Reptilia of the Wealden and Purbeck Formations (with Supplements 1, 2, 3), by Prof. Owen, COMPLETE ‡ | 1853, 1854, 1855, 1856, 1857, 1858, 1862 | 1853, 1855, 1857, 1858, 1859, 1861, 1864 | 155 | 62 | 251 | 17 |
| The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), COMPLETE | 1871, 1873, 1876, 1878, 1879, 1888*n* | 1872, 1874, 1876, 1878, 1879, 1889 | 85 | 21 | 175 | 15 |
| The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, COMPLETE | 1859, 1860, 1868, 1888*n* | 1861, 1863, 1869, 1889 | 16 | 6 | 23 | 4 |
| The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE | 1859,‖ 1860,‖ 1863, 1869, 1881*n* | 1861, 1863, 1865, 1870, 1881 | 174 | 50 | 276 | 20 |
| The Reptilia of the Mesozoic Formations, by Prof. Owen, COMPLETE | 1873, 1875, 1877, 1888*n* | 1874, 1875, 1877 | 101 | 24 | 165 | 17 |
| The Red Crag Cetacea, by Prof. Owen, COMPLETE | 1869, 1888*n* | 1870, 1889 | 42 | 5 | 43 | 9 |
| The Fossil Elephants, by Prof. Leith Adams, COMPLETE | 1877, 1879, 1881*n* | 1877, 1879, 1881 | 265 | 28 | 216 | 3 |
| The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, *in course of completion* | 1864, 1867, 1868, 1871, 1878, 1886 | 1866, 1868, 1869, 1872, 1878, 1887 | 333 | 39 | 340 | 12 |
| The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE | 1870 | 1871 | 115 | 4 | 247 | 30 |
| TOTAL..... | | | 13801 | 1880 | 34288 | 6606 |

*a* Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
*g* Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
*l* Index will be found in 1878 vol. *m* Useful for establishing the dates of new species. *n* Contains title-pages and directions for binding.
‡ Title-pages and Index will be found in the 1864 Volume. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

## § V. Stratigraphical Table *exhibiting the* British Fossils *already figured and described in the* Annual Volumes (1847—1895) *of the* Palæontographical Society.

| | PROTOZOA. | | | RADIATA. | | ARTICULATA. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | PLANTS. | Sponges. | Foraminifera. | Stromatoporoids and Corals. | Echinodermata. | Cirripedes. | Cypridæ, Cytherinæ, &c. | Phyllopoda. | Merostomata. | Trilobites. | Malacostracous Crustacea. |
| Pleistocene ..... | ... | ... | ... | ... | ..... | ..... | 1874, 1888 | | | | |
| Crag ..... | ... | ... | 1865, 1895 | 1849 | 1852 | 1851, 1854 | 1888 | | | | |
| Eocene ..... | 1879, 1880, 1882, 1883, 1884, 1885 | ... | ... | 1849, 1865 | 1852 | 1851, 1854 | 1855, 1888 | ... | ..... | ..... | 1856 |
| Cretaceous..... | ... | ... | ... | 1849, 1868, 1869 | 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882, 1890, 1893 | 1851, 1854 | 1849, 1889 | ... | ..... | ..... | 1860 |
| Wealden ..... | ... | ... | ... | ... | ..... | ..... | ... | 1860 | | | |
| Oolitic ..... | .. | 1893 | ... | 1851, 1872 | 1855, 1856, 1857, 1858, 1861, 1878, 1880 | 1851 | ... | 1860 | | | |
| Liassic ..... | ... | 1893 | ... | 1851, 1866, 1867 | 1855, 1856, 1858, 1861, 1864 | | | | | | |
| Triassic ..... | ... | ... | ... | ... | 1880 | ..... | ... | 1860 | | | |
| Permian ..... | 1849 | 1849 | 1849, 1876 | 1849, 1852 | 1849 | ..... | 1849 | 1860 | | | |
| Carboniferous... | 1867, 1870, 1871, 1875, 1886 | 1887 | 1876 | 1852 | ..... | ..... | 1874, 1884 | 1860, 1887 | 1872, 1878 | 1883, 1884 | |
| Devonian ..... | ... | 1887 | ... | 1853, 1885, 1888, 1890, 1892 | 1895 | ..... | 1888 | 1860 | 1865, 1868, 1872, 1878 | 1862, 1888 | |
| Silurian. ..... | ... | 1886, 1887 | ... | 1854, 1885, 1890 | ..... | ..... | ... | 1887, 1892 | 1868, 1871, 1872, 1878 | 1862, 1863, 1864, 1866 | |
| Cambrian ..... | ... | 1886, 1887 | ... | 1890 | ..... | ..... | ... | 1887 | ..... | 1864 | |

Note.—The numbers in the above List refer to the Volumes issued for those Dates.

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1895) *of the* PALÆONTOGRAPHICAL SOCIETY (*continued*).

| | MOLLUSCA. | | | | VERTEBRATA. | | |
|---|---|---|---|---|---|---|---|
| | Polyzoa. | Brachiopoda. | Monomyaria, Dimyaria, and Gasteropoda. | Cephalopoda. | Fishes. | Reptiles. | Mammalia. |
| Pleistocene ..... | ... | 1873 | ..... | .. | ... | ..... | 1864, 1867, 1868, 1871, 1877, 1878, 1879, 1881, 1886 |
| Crag ..... | 1857 | 1852, 1873, 1879 | 1847, 1850, 1853, 1855, 1871, 1873, 1879, 1882 | ... | ... | ..... | 1869, 1881, 1888 |
| Eocene ..... | ... | 1852, 1873 | 1852, 1854, 1855, 1858, 1859, 1862, 1870, 1877 | 1848 | ... | 1848, 1849, 1856, 1880 | |
| Cretaceous..... | ... | 1852, 1854, 1873, 1884 | 1872, 1875, 1877, 1879 | 1853, 1854, 1855 | ... | 1851, 1857, 1858, 1862, 1873, 1888 | |
| Wealden ..... | ... | ... .. | .... | ... | ... | 1853, 1854, 1855, 1856, 1857, 1862, 1871, 1873, 1875, 1876, 1878, 1879 | |
| Oolitic ... .. .. ... | ... | 1850, 1852, 1876, 1878, 1884 | 1850, 1853, 1854, 1872, 1874, 1875, 1877, 1879, 1883, 1886, 1887, 1888, 1889, 1891, 1892, 1894, 1895 | 1850, 1861, 1868, 1869, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1894 | ... | (Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868, 1873, 1875, 1877, 1888 (Great Oolite) 1875, 1888 | 1870 |
| Liassic ..... | ... | 1850, 1852, 1876, 1878, 1884 | 1874, 1877, 1879, 1883 | 1863, 1864, 1866, 1868, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885 | ... | 1859, 1860, 1863, 1869, 1873, 1881 | |
| Triassic..... | ... | 1876, 1878 | 1879 | ..... | 1878 | ..... | 1870 |
| Permian ... ..... | 1849 | 1849, 1856, 1880 | 1849 | 1849 | 1849 | 1849 | |
| Carboniferous ... | ... | 1856, 1857, 1858, 1859, 1860, 1880, 1884 | 1894, 1895 | ..... | 1877 | | |
| Devonian ..... | 1895 | 1862, 1863, 1881, 1882, 1884, 1893 | 1890, 1891, 1892, 1893 | 1889 | 1867, 1869, 1894 | | |
| Silurian..... | ... | 1865, 1866, 1868, 1870, 1881, 1882, 1883 | | | | | |
| Cambrian ..... | | | | | | | |

NOTE.—The numbers in the above List refer to the Volumes issued for those Dates.

THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1895

LONDON

MDCCCXCV.

A MONOGRAPH

OF THE

# FORAMINIFERA OF THE CRAG.

PART II.

CONTAINING

PAGES i—vii, 73—210; PLATES V, VI, VII.

BY

PROFESSOR T. RUPERT JONES, F.R.S., F.G.S.,

HON. MEM. GESELL. ISIS, DRESDEN, SOC. BELG. MICROSC., AND SOC. GÉOL. PALÉONTOL. HYDROL. BRUX.,
GEOL. ASSOC. LOND., GEOL. SOCS. EDIN., GLASG., ROY. IRISH GEOL. SOC., AND ANTHROP.
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AND ACAD. NAT. SCI. PHILAD., ETC.

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## CORRECTIONS IN THE EXPLANATIONS OF PLATES I—IV.

Plate I, fig. 21, should be *Marginulina costata* (Batsch).
„ „ 29—31, should be *Lagena lagenoides*, Williamson.
„ „ 42, 43 „ *Lagena acuticosta*, Reuss.
„ „ 55—58 „ *Polymorphina nodosaria*, Reuss.
„ „ 61 „ *Dimorphina tuberosa*, d'Orb.
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„ IV „ 1 „ *Miliolina triangularis* (d'Orb.).
„ „ 2 „ *Miliolina bicornis* (W. and J.), Var. *Brongniartii* (d'Orb.).
„ „ 3 „ *Miliolina pulchella* (d'Orb.).
„ „ 4 „ *Miliolina Ferussacii*, (d'Orb.), Var.
„ „ 7 „ *Lagena reticulata* (Macgillivray).
„ „ 8 „ *Nodosaria proxima*, Silvestri.
„ „ 18 „ *Truncatulina Haidingeri* (d'Orb.).

## CORRECTIONS FOR PART I.

Page 15, last line but one in the synonyms, *instead of* p. 466 *read* 470.
„ 26, line 8 from bottom, *for* Schlotheim *read* Geinitz.
„ „ 7 „ „ Kirby „ Kirkby.
„ 32, 15th line of the synonyms, *instead of* Ib. *read* Ann. Mag. Nat. Hist., ser. 2.
„ 34, 5th „ „ *for* 307 *read* 317.
„ „ 6th „ „ „ p. 6 „ pp. 268, 269; and *for* pl. i *read* pl. v.
„ 40, line 2 from bottom, *for* Pliocene *read* Pleistocene.
„ 44, 2nd line of the synonyms, *for* 319 *read* 318.
„ „ 4th „ „ „ 40, 41 „ 90, 91.
„ 48, 52, 70, *for* Upper Trias of Chellaston „ Lias of Leicestershire (?).
„ 47, 48, 55, 59, 61, *for* Neuegeboren „ Neugeboren.
„ 47, line 17 from bottom, *for* 68 *read* 48.
Foot-note at page 61 „ Marguline „ Marginuline.
Page 64, line 8 from bottom, *for* Genus „ Species.
„ 69 „ 2 „ of text, *for* Smith's „ Smithsonian.

## CORRECTIONS FOR PART II.

Page 114, line 3 from top, *for* p. 33 *read* p. 107.
„ 123 „ 6 „ „ *Montagu* read *Walker and Jacob.*
„ 157 „ 1 and 2, TEXTULARIA GLOBULOSA, *Woodward and Thomas*, 1885 . . . . figs. 1—5 is T. GIBBOSA, and should be transferred to p. 153.
„ 159 „ 1 and 2 *read* Charente-Inf. Annales.
„ „ „ 4 „ (Rend.).
„ „ last line but one, *read* Ak. Wiss.
„ 175, *insert before* LAGENIDÆ, &c.—

III. VITREA, HYALINA, *vel* PERFORATA.

Shell calcareous; perforate and hyaline in structure. (Those of the *Perforata* that in great part take on an *arenaceous* investment are included in the *Arenacea.*)

*Cristellariæ* have such narrow and much-curved chambers that they are separable as *C. vortex;* and there are other extreme conditions of variable features which have been conveniently adopted as grounds for separate names. Some *Cristellariæ* are not discoidal, but have become oval, and more or less oblong by the growth of segments that leave the spiral arrangement, and follow a nearly direct line, with their inner edges reaching down (backwards) to touch the spiral part of the shell; and they thus become elongate and either flattened, as *Cristellaria crepidula* (Fichtel and Moll), or thick and subtriangular in section, as *C. Italica* (Defrance). Others keep their later chambers quite free of the spire, like *C. subarcuatula* (Walker and Jacob), and thus pass into *Marginulina.*

There are other less marked distinctions of subordinate importance, depending upon surface-ornamentation, the thickening of the central portion of the shell into an umbo, and the septal lines into ribs, or other similar characters, due to exogenous shell-growth. The shape of the pseudopodial or stoloniferous orifice is, as in other Foraminifera, somewhat variable. In *C. cultrata* it is often triangular; and upon specimens having this peculiarity M. d'Orbigny founded his genus *Robulina.* Professor Williamson, Dr. Carpenter, and others have shown how untenable such a distinction really is.

*Cristellaria calcar* (Linné) serves as a central type for this sub-group of *Nodosarina.* We have already indicated the interchangeableness of the *Cristellariæ* with others of this great generic group. Without entering further upon the intricate polymorphism of *Cristellaria*, we proceed to describe our specimens from the Crag.

We begin with *C. cultrata* (Montfort); and ignoring the non-essential differences in carination, limbation, thickening of umbones, and relative size and gibbosity of the chambers, we have to draw up a very long list of synonyms for the little *Cristellaria* before us, which belongs to the form known as *C. cultrata.* Indeed, zoologically it is very difficult to separate *C. cultrata* from *C. rotulata* and *C. Italica* on one hand, or from *C. calcar* and *C. cassis* on the other, whilst the distinctions of ornament are found to fade away one into another. With the *Cristellariæ*, as with other Foraminiferal groups, we have to deal with the variability of individuals; and for convenience of grouping and reference we must artificially define nominal species, varieties, and even sub-varieties. We confine ourselves, therefore, to the smooth, orbicular, keeled *Cristellariæ*, with a modicum of septal overgrowth and of umbonal thickening, as typical of *C. cultrata.*

# PART II.

## I. INTRODUCTORY REMARKS.

Part I of the Monograph of the Foraminifera of the Crag was unavoidably left unfinished in 1866. Two of the joint authors have unfortunately been removed from among us by death, and their fellow-worker has been hindered by many circumstances hitherto from completing the Monograph.

It is proposed that in Part II[1] additions and corrections, in many cases necessary, be made for the genera and species already dealt with; and that the descriptive work should comprise such groups as precede *Lagena* and its allies in the more modern classification. A considerable quantity of MS. prepared by the late Dr. H. B. Brady, after 1866 for this Part II, has been advantageously incorporated.

The descriptions will be rendered in as short a form as possible by limiting them to concise notes on the characters, distribution, and peculiarities of shape and structure, such as the same authors used in the "Memoir on the Foraminifera of the Abrohlos Bank" ('Trans. Zool. Soc.,' vol. xii, part 7, 1888, pp. 211—239); and as Dr. Egger has lately made use of in his "Memoir on the Foraminifera from the Soundings obtained by the 'Gazelle'" ('Abhandl. k. Bayer. Akad. Wiss.,' vol. xviii, part 2, 1893, pp. 195—266),—in each case references to the Report[2] on the Foraminifera brought home by the 'Challenger' being made for the synonymy down to 1884, as far as applicable and convenient. The system of classification, also, and of nomenclature used by Dr. H. B. Brady in that Report will be adhered to as much as possible. This plan has been followed by Dr. Carlo Fornasini ('Boll. Soc. Geol. Ital.,' 1889), by Signor M. Malagoli ('Atti Soc. Nat. Modena,' 1888) and others.

Having lately had opportunities of studying the original figured specimens of Foraminifera from the Crag—both those formerly in Mr. S. V. Wood's and those in Professor W. K. Parker's Collection—all being now in the British Museum (Natural-History Branch), we have been able to examine the figured

[1] Written in 1895.

[2] 'Report on the Foraminifera dredged by H.M.S. 'Challenger' during the years 1873—1876.' Reports of the Scientific Results of the Voyage of H.M.S. 'Challenger,' vol. ix (Zoology), 4to, London, 1884, pp. 814, with volume of 115 plates.

specimens as far as requisite, and to recognise some forms that had not been published in Part I.

Other sources of information have been several selected examples of Crag, collected by Professor Prestwich from the "Zones" defined by himself in 1871, and other samples specially taken from the several zones by Mr. H. W. Burrows. Long conversant with the fossils of the Crag, and with the Foraminifera in particular, Mr. Burrows, in co-operation with Mr. R. Holland, has worked assiduously on these microzoa; and they now enrich this Monograph with the results, both by excellent figures of the Foraminifera shown in Plates VI and VII, by the notes throughout this Part of the Monograph on the geographical and geological distribution of the several species, and by Tables of the genera and species. Mr. Burrows has also contributed the valuable stratigraphical notes on the divisions of the Crag. Other courteous and obliging friends—namely, Mr. C. D. Sherborn, Mr. F. W. Millett, and Mr. F. Chapman—have given valuable help in several ways in determining the relationship of the forms, and their bibliography and synonymy.

Plate V contains many of the forms selected from the old collections, which, after having been photographed, were lithographed, in company with some from Mr. Millett's and Mr. Chapman's collections, by Messrs. George West and Sons, with their usual conscientious exactitude. Plates VI and VII were lithographed by them from drawings kindly made by Messrs. Burrows and Holland, from specimens which, with the few exceptions noted in the Explanations of the Plates, are from their own collections, and have not been previously recorded from the Crag.

# II. THE STRATIGRAPHY OF THE CRAG:

## WITH NOTES ON THE DISTRIBUTION OF ITS FORAMINIFERA.

By Henry W. Burrows, A.R.I.B.A., &c.

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Since the publication, in 1866, of the First Part of this Monograph, much light has been thrown upon the stratigraphical relations of the Crag deposits of this country and abroad, so that many modifications of the views then held have become necessary.

The whole of the Pliocene beds of the British Isles have been exhaustively dealt with by Mr. Clement Reid in his "Pliocene Deposits of Britain,"[1] to which is appended a full Bibliography of works relating to Pliocene strata, both English and foreign.[2]

The latest views on the subject are embodied in the following classification,

[1] 'Memoirs Geological Survey,' 1890.

[2] For the foreign equivalents to English Pliocene strata, and correlation of foreign Tertiary strata generally, consult G. F. Harris's "Approximate Correlation of the Tertiary Beds of Europe,"

for which I am mainly indebted to the work referred to; but, to make a comparison with the First Part of this Monograph clearer, notes have been added in square brackets (see Table, p. 5).

The distribution of Foraminifera throughout this series will best be understood by discussing the several beds in detail.[1]

BRIDLINGTON BEDS.—It will be noticed that the so-called "Bridlington Crag" is omitted from the following classification, as that deposit is now definitely regarded as Pleistocene.[2] The Foraminifera indicated in the twelfth column of the "Table showing the Distribution of the Foraminifera in the Crag Deposits," Appendix II of the First Part of this Monograph, are therefore (unless for comparison) not further described.

## NEWER PLIOCENE [UPPER CRAG].

BEDS ABOVE THE RED CRAG.—Our knowledge of the distribution of Foraminifera in the entire series of Upper Crag beds remains, unfortunately, in almost precisely the same condition as that tabulated in the list already referred to, with the following few additions for the Chillesford Beds of Aldeby, near Beccles.

*Nodosaria raphanus* (Linn.), vs. VR.[3]
*Textilaria globulosa*, Ehrenb., s. VR.
*Polymorphina tuberculata*, d'Orb., m. VR.
*Planorbulina mediterranensis*, d'Orb., m. VR.

RED CRAG.—The coarse quartzose sand and ferruginous condition of the Red Crag beds were not favorable to the presence and preservation of Foraminifera; but a more extended research in the finer and lighter coloured sands would, no doubt, prove profitable, although a prolonged search through some of the grey sand,

in R. B. Newton's 'Syst. List F. E. Edwards's Coll. British Oligocene and Eocene Mollusca' (Appendix), 1891, pp. 327—340.

For details of Belgian Pliocene stratigraphy see "Esquisse géologique et paléontologique des dépots pliocènes des environs d'Anvers," by E. Vanden Broeck, 'Ann. Soc. Malac. Belg.,' vol. ix, 1874, pp. 83—374; and of Italian Pliocene, &c., "Classification des Terrains tertiaires conformé à leurs facies," by F. Sacco, 'Bull. Soc. Belge de Géol.,' &c., vol. i, 1887, pp. 276—294.

[1] The remarks on the distribution of Foraminifera are based upon the examination of material collected by me during the past eight years, with the exception of some from Tattingstone and Gedgrave (Zone g) kindly given by Prof. Prestwich. The whole of this material has been worked over by Mr. R. Holland and myself; and Mr. F. Chapman gave us some assistance with the Tattingstone Crag. For complete lists see Appendix.

[2] For references see C. Reid, op. cit., p. 208.

[3] vs. very small; s. small; m. middling; VR. very rare.

CLASSIFICATION OF THE PLIOCENE DEPOSITS OF BRITAIN, AND THEIR PRINCIPAL FOREIGN EQUIVALENTS.

| | ENGLAND. | BELGIUM AND HOLLAND. | ITALY. |
|---|---|---|---|
| Pleistocene | Arctic Freshwater Bed (with *Salix polaris*, *Betula nana*, &c.) [Mundelesy, Beeston, &c.] | ? | Sicilian (with recent marine mollusca). |
| [Upper Crag] Newer Pliocene (Cold temperate) | *Leda* [= *Nuculana*] *myalis* Bed (classed provisionally with the Pliocene) [West Runton, Beeston, &c.] | | Astian: Villafranchian sub-stage, Continental facies. |
| | Forest-bed series [Cromer, &c.]: Upper Fresh-water (Gravels with *Elephas meridionalis* at Dewlish); Estuarine; Lower Fresh-water | | |
| | Weybourn Crag (and Chillesford Clay ?) | | Fossanian sub-stage, Littoral and Estuarine facies. |
| | Chillesford Crag | | |
| | Norwich [Fluvio-marine or Mammaliferous] Crag and *Scrobicularia* Crag | | |
| | Red Crag of Butley, &c. | | |
| | Walton Crag (Lower Red Crag) | Scaldisian; sands with *Chrysodomus antiqua* | Astian sub-stage, Marine facies. |
| [Lower Crag] Older Pliocene (Warm temperate) | St. Erth Beds [near Marazion, Cornwall] | | |
| | "Coralline" [Suffolk, Lower, White, Bryozoan, or Zoophytic] Crag, and Lenham Beds | Casterlian; sands with *Glossus cor*. Diestian; sandstone and sands of Edeghem, with *Glycymeris Menardi* | Plaisancian. Fossiliferous blue argillaceous marls. |
| | [Nodule Beds] Box-stones and phosphate-beds at the base of the Red and Coralline Crags (with *remanié* early Pliocene fossils) [Sutton, Felixstowe, Foxhall, Waldringfield, &c.] | | |
| | Wanting | Wanting | Messinian: An alternation of marls, sands with estuarine fossils, calcareous and gypseous deposits, thick sandstones and conglomerates. |
| Miocene | Wanting | Bolderian | Tortonian. |

so rich in Mollusca, from Walton-on-the-Naze, has not resulted in any additions to the recorded species.

## OLDER PLIOCENE [LOWER CRAG].

ST. ERTH BEDS.—At St. Erth, near Marazion, Cornwall, a very small outlier of sands and clays occurs, the Pliocene age of which was definitely established by the late Mr. S. V. Wood, jun.;[1] and later a full description of the exposure was given by Messrs. P. F. Kendall and R. G. Bell,[2] from which the following section is taken [with the dimensions added from Mr. C. Reid's 'Memoir,' p. 60]:

Vegetable soil.

| | |
|---|---|
| 3 ft. to 7 ft..... | Bed 1. "Head," an argillaceous deposit with angular fragments of Killas and other rocks; probably of glacial origin. |
| | 2. Fine yellow sand. |
| | 3. Yellow clay, without fossils; separated from Bed 2 by a thin layer of coarse sand ("Growder"). |
| 1 ft. 6 in. to 3 ft.... | 4. Blue clay, with many fossils. |
| | 5. Layer of scattered quartzose pebbles. |
| | 6. Fine quartzose sand, yellow above and purplish below. |
| | 7. Very coarse, highly ferruginous sand ("Growder"). |

The thickness of the several beds is very variable, and the total depth of the pit 12 feet to 14 feet. No. 4 is the fossiliferous bed, in which nearly all the organic remains were found.

The Foraminifera have been most carefully worked out by our friend Mr. Fortescue W. Millett, and the lists published by him[3] give a total of 163 species and well-marked varieties. Of this number seventy-six are also met with in the Coralline Crag, the additions now made to the rhizopodal fauna of the latter emphasising the similarity to a considerable degree.

Mr. Millett says in his "Additional Notes," "Every day the difficulty of ascertaining the age of any particular bed by the Foraminifera it contains becomes more evident; for rarely does it happen that an investigation is made of any deposit, recent or fossil, which does not extend our knowledge of the existence of

[1] "On a New Deposit of Pliocene Age at St. Erth, near the Land's End, Cornwall," 'Quart. Journ. Geol. Soc.,' vol. xli, 1885, pp. 65—73.

[2] "On the Pliocene Beds of St. Erth," 'Quart. Journ. Geol. Soc.,' 1886, pp. 201—215.

[3] F. W. Millett, "Notes on the Fossil Foraminifera of the St. Erth Clay Pits," 'Trans. Roy. Geol. Soc. Cornwall,' vol. x, pt. 7, 1885, pp. 213—216; "Additional Notes on the Foraminifera of the St. Erth Clay," op. cit., vol. x, 1886, pp. 222—226; "The Foraminifera of the Pliocene Beds of St. Erth," op. cit., vol. xi, 1894, pp. 655—661.

several species in localities or periods where they were before unknown. Thus, in this presumably Pliocene deposit, we have forms which hitherto have been known to exist only in Eocene or Miocene periods; whilst, on the other hand, there are several species which, now living in the seas in various parts of the world, are here for the first time found fossil."

To a certain extent this is undoubtedly true; but making allowance, as we should, for the difference of sea-bottom and the nature of each deposit—the St. Erth fossiliferous bed consisting of a fairly pure clay, and the Coralline Crag of Bryozoan and Molluscan detritus—we naturally expect to find considerable differences in the entombed organisms. We thus find a very rich assemblage of *Lagenæ* in the St. Erth beds (thirty-six species), while but *twenty-three* are recorded from the Coralline Crag, of which *eighteen* are common to the two. One of the most interesting recorded is *Lagena seminuda*, Brady, a species only met with at six stations by the 'Challenger,' two in the South Atlantic and four in the South Pacific, with a range of depth from 1300 to 2350 fathoms. In the St. Erth clay it is rare; but in the Coralline Crag at Sutton (Zone **f**) it is rather common, so that we have in the Pliocene the earlier appearance of a comparatively shallow-water form, which has since migrated to deeper seas. The *Polymorphinæ* so well represented in the Coralline Crag appear to be somewhat rare at St. Erth, but of the fifteen recorded species ten are also found in the Coralline Crag.

Taken altogether, the balance of evidence, so far as the Foraminifera are concerned, supports the arguments adduced by Mr. C. Reid for the inclusion of the St. Erth Beds with the *Older*, rather than with the *Newer* Pliocene, as suggested by Messrs. P. F. Kendall and R. G. Bell.[1]

As the scope of this Monograph is limited to the Foraminifera of the Crags of the Eastern Counties, it is not proposed to further describe the St. Erth forms, more especially as they have already been so ably dealt with by Mr. Millett; and we learn from him that "there are still many species undetermined, which will form the subject of a concluding notice." The species common to the Coralline Crag and St. Erth beds are tabulated in the Appendix.

CORALLINE CRAG.—As it is from this division of the Crag deposits that we have obtained by far the largest and best assortment of species of Foraminifera, its subdivisions will be more fully dealt with.

Subsequent to the publication of Part I of this Monograph Professor Prestwich[2] published his researches on these beds, and subdivided the Coralline Crag into several zones, to each of which he assigned an index letter. The total thickness

[1] For the relation of the St. Erth beds to those of Cotentin see C. Reid, 'Pliocene Deposits of Britain,' 1890, p. 67.

[2] J. Prestwich, "On the Structure of the Crag-beds of Suffolk and Norfolk." Part I. The Coralline Crag of Suffolk," 'Quart. Journ. Geol. Soc.,' vol. xxvii, 1871, p. 115, *et seq.*

of the deposit he estimated at 83 feet. In 1872 Messrs. S. V. Wood, jun., and F. W. Harmer[1] questioned "the constancy or determinability of such horizons;" and, by another method of calculation, arrived at the conclusion that the total thickness of the Coralline Crag does not exceed 60 feet. That there are two main divisions of the Coralline Crag is recognised by the several writers, and appended is a comparison of their views.

General Section of the Coralline Crag.

| | | After Professor Prestwich. | | | After Messrs. S. V. Wood, jun., and F. W. Harmer. |
|---|---|---|---|---|---|
| | Zone. | Thickness. | Character of beds. | Localities. | |
| Upper Division 36′ 0″. | h | 6′ 0″ | Sand and comminuted shells | Sudbourne, Gedgrave | 3‴. Bed reconstructed out of 3″ comminuted. |
| | g | 30′ 0″ | A series of beds consisting almost entirely of comminuted shells and remains of Bryozoa, forming a soft building stone. False stratification and oblique bedding are its constant characters | Sutton, Sudbourne, Gedgrave, Iken, Aldborough | 3″. Solid bed of Molluscan remains, with various species of Bryozoa. "The Bryozoa rock-bed of the Coralline Crag." |
| Lower Division 47′ 0″. | f | 5′ 0″ | Sand with numerous entire shells and seams of comminuted shells | Sutton, Iken, Sudbourne, Gomer | |
| | e | 12′ 0″ | Sands with numerous Bryozoa, often in the original position of growth, and some small shells and Echini | Sutton, Broom Hill | |
| | d | 15′ 0″ | Comminuted shells, large entire or double shells, and bands of limestone in the upper part | Sutton, Broom Hill, Sudbourne, Iken, Tattingstone | 3′. Calcareous sands, in some places more or less marly, rich in Molluscan remains. "The shelly sands of the Coralline Crag." |
| | c | 10′ 0″ | Marly beds with numerous well-preserved and double shells, often in the position in which they lived | Sutton, Ramsholt | |
| | b | 4′ 0″ | Comminuted shells, Cetacean remains, Bryozoa | Sutton | |
| | a | 1′ 0″ | Phosphatic nodules and Mammalian remains | Sutton | |
| Total | | 83′ 0″ | | | Total thickness 60 feet. |

[1] 'Supplement to the Crag Mollusca,' Palæontograph. Soc., 1872, p. ii, *et seq.*

1. Sutton and Ramsholt.—Zones **a**, **b**, and **c**.

The lowest zones of the Coralline Crag were exposed only in the long since disused pits at Sutton and Ramsholt. The old pit on Mr. Colchester's farm at Sutton, south side of Sutton Farm Hill, showed in 1860 the following section :[1]

| | | |
|---|---|---|
| | Surface soil . . . . . | 1′ 0″ |
| Zone **d**. | White marly sands with seams of *Cyprina* [= *Arctica*] | 17′ 0″ |
| „ **c**. | Ditto with *Mya* and *Bryozoa* in lower part, and *Cardita*, *Astarte*, *Anomia*, and *Venus* common in upper part | |
| | [This bed is stated to have been rich with Foraminifera] | |
| „ **b**. | Bed of comminuted shells, with single valves of *Cyprina* [= *Arctica*], *Pecten* [= *Chlamys*], *Cellepora cæspitosa*, &c. . . . | 4′ 0″ |
| „ **a**. | Bed of phosphatic nodules, with Cetacean and other Mammalian remains and foreign boulders . . . . . | 1′ 0″ |
| | [Nodule-Bed.] | |
| | London Clay. | |

The Ramsholt pit was correlated with part of bed **c**.

2. Broom Hill.—Zones **d** and **e**.

Pit near the Keeper's Lodge, one mile west of Orford Church.

The following section is given by Prof. Prestwich :[2]

| | | |
|---|---|---|
| | Surface and drift soil . . . . . | 3′ 0″ |
| Zone **e**. | Yellow sand, full of *Fascicularia*, *Alveolaria*, and *Cellepora* ; few shells . | 7′ 0″ |
| „ **d**. | Sandy bed with comminuted shells, thin bands of tabular limestone, layers of large and entire shells, and a few Bryozoa. The lower bed is full of fine entire *Cyprinæ*, *Thraciæ*, *Diplodontæ*, *Terebratulæ*, and *Carditæ*, often double . . . . . | 15′ 0″ |

The bed **d**, so far as I have seen on the many visits made to this pit, must have been somewhat lenticular and have thinned out, as it does not now (1894) exceed 10 to 12 feet in thickness.

Foraminifera are abundant in this section in both zones, as the lists appended show. In zone **d**, in addition to those forms common to most Coralline Crag exposures, *Polystomella crispa* is perhaps the most common, together with fine specimens of *P. macella*. Some of the *Polymorphinæ*, as *Polymorphina froudiformis*, *P. complanata*, *P. compressa*, and *P. gibba*, are very large and well grown ; and the same remark applies to *Pulvinulina repanda*. *Cassidulina lævigata*, not usually a common form in the Coralline Crag, is also fairly plentiful in this zone. In zone we notice the same abundance of *Polystomella crispa*, large and well developed.

[1] Prof. Prestwich, 'Quart. Journ. Geol. Soc.,' vol. xxvii, 1871, p. 117.

[2] Op. cit., p. 122.

Other common species are *Textilaria sagittula*, *Truncatulina lobatula*, *T. Haidingerii*, and *Rotalia Beccarii*. On the other hand, *Nonioninæ* are rare and the specimens small. There is also a remarkable absence of Milioline forms.

3. Sudbourne Hall.—Zone **d**.

I measured the following section in the pit directly in front of the Hall in 1886, and it is still (1894) in the same condition.

| | | |
|---|---|---|
| | Surface soil and drift . . . . . | 1′ 6″ |
| Zone d. | Fine white Coralline Crag, full of comminuted shells and Bryozoa, rich in *Scaladiæ* . . . . . | 3′ 0″ |
| | Marly Crag, buff-coloured and greenish at the base; full of fine shells, *Cardita senilis*, *Arctica Islandica*, *Chlamys opercularis*, *Astarte Omalii*, &c. . . . . | 3′ 6″ |

This pit is referred, somewhat doubtfully, by Prof. Prestwich to the Zone **d**; but the Mollusca, especially the band with *Arctica islandica*, in a greenish to buff-coloured Crag, so distinctive of this zone at Broom Hill, Sutton, and elsewhere, together with the Foraminifera, confirm this view. Some of the latter are here very fine; specimens of *Polymorphina frondiformis* 5 mm. long, and of *P. complanata* 4 mm. long, being not uncommon. *Polymorphina variata* is also plentiful and well grown, together with *Textilaria agglutinans* (varieties) and *T. trochus*.

4. Tattingstone (Park Farm).—Zone **d**.

We are indebted to Prof. Prestwich for some material from the outlier of Coralline Crag which occurs at this locality, four and a half miles south-south-west of Ipswich. The section is now much obscured and overgrown; but originally about eight feet of Coralline Crag was exposed, underlying Red Crag, in the following section:[1]

| | | |
|---|---|---|
| | 1. Coarse gravel. Drift. | |
| Red Crag | 2. Ochreous sand, with seams of ironstone, &c. . . | 12′ 0″ |
| | 3. Crag with a few coprolites . . . . | |
| | 4. Light-coloured sand . . . . . | |
| | 5. White sand . . . . . | |
| | 6. Brown loam . . . . . | |
| | 7. Not described . . . . . | |
| | 8. Coralline Crag . . . . . | 8′ 0″ |

The Coralline Crag of this section is referred, with doubt, by Prof. Prestwich to his zone **d**; but an examination of the Foraminifera shows a somewhat

[1] Prof. Prestwich, 'Quart. Journ. Geol. Soc.,' vol. xxvii, 1871, p. 342. See also, for other sections at Tattingstone, "Geology of Ipswich," &c., 'Mem. Geol. Surv.,' 1885, pp. 26 and 47.

different fauna from that of other localities referred to this zone. *Lagenæ* are fairly plentiful, the species *Lagena lacunata* and *L. melo*, which are not often met with in other exposures of Coralline Crag, being rather common. Other forms of Foraminifera are somewhat rare, with the exception of those species which range through the entire formation.

5. Sutton.—Zones **e**, **f**, and **g**.

The pits in this classical locality, well known to all students of the Coralline Crag, are now somewhat obscured, weathered, and overgrown. The celebrated Bullock-yard pit, about 250 yards south-west of Pettistree Hall, furnished the late Mr. S. V. Wood with the bulk of his extensive collection of Mollusca from this formation. On visiting the locality in August, 1894, a comparatively fresh exposure of the Crag was visible in the outlier, at some forty to fifty yards to the north of the Bullock-yard pit, and facing Pettistree Hall; it shows the following section :

| | | |
|---|---|---|
| | Surface soil, dark purple-brown . . . . . | 2′ 0″ |
| Zone **g**. | Hard, ferruginous, false-bedded Coralline Crag; full of Bryozoa and shells, many broken . . . . . | 2′ 0″ to 3′ 0″ |
| „ **f**. | Buff sandy Crag; full of small shells, *Scala*, *Bullinella*, *Adeorbis*, *Ringicula*, *Chlamys*, &c. . . . . | 5′ 0″ |
| „ **e**. | Buff-coloured marly Crag; very few shells, in scattered bands . . | 4′ 6″ |

The Bullock-yard section shows the same sequence, but the zone **e** is 7 feet deep. In the sections published by Prof. Prestwich the bed **e** showed 4 feet, and bed **g** 11 feet. It would thus seem that the beds are lenticular and unevenly bedded.

The zone **g** is far too ferruginous to form a promising field of research for Foraminifera, and attention was therefore chiefly directed to zones **e** and **f**, which have yielded us a rich Foraminiferal fauna ; but many of the forms recorded in the First Part of this Monograph have not been found, although they were then stated to be of common occurrence at Sutton. On this point Messrs. S. V. Wood, jun., and F. W. Harmer say,[1] "At this spot, moreover [Sutton, and by inference, supported by inquiries made at the locality, the Bullock-yard pit], Foraminifera were once abundant, and from it Mr. Wood collected all the species obtained by him from the Coralline Crag which are described in the Monograph of Messrs. Jones and Parker [and Brady]. No Foraminifera, however, have been found by him there for many years, although very many tons of the Crag from the same spot have been sifted by him for Mollusca during that period."

[1] 'Supplement to the Crag Mollusca,' Palæontograph. Soc., 1892, p. iv.

Despite the remarks quoted above, the Sutton pits still yield a rich Rhizopodal fauna, many of the species being fully grown and perfect, occurring in great profusion, notably in zone **f**, where we find *Polymorphina frondiformis*, *P. variata*, *P. gibba*, *P. complanata*, *P. communis*, *Textilaria gibbosa*, *Biloculina ringens*, &c.; while the *Lagenæ*, though somewhat rarer individually, are numerous in species. Some of the specimens are gigantic, comparatively speaking; *e. g. Dentalina pauperata*, 6 mm. long, *D. obliqua*, 7 mm. long, *Polymorphina nodosaria*, 4 mm. long, and *Dimorphina tuberosa*, 4 mm. long, are not infrequent. In zone **e**, the species common in the same zone at Broom Hill are also plentiful here; but *Nonionina scapha*, which is there somewhat rare, is very common, and the specimens well developed. Moreover *Miliolinæ* are rather common, as are also *Planorbulina mediterranensis* and *Discorbina rosacea*.

It seems probable, therefore, that the greater number of the Foraminifera recorded from Sutton in the First Part of this Monograph were from zone **f**; but, if that were not so, it is now impossible to separate those found in zone **e**.

6. Gedgrave.—Zones **f**, **g**, and **h**. These zones are well shown in the pits at High and Low Gedgrave, one and a half miles south-west of Orford, in the following sections, measured in August, 1894:

*Pit close to High House, Gedgrave.*

| | | |
|---|---|---|
| | Surface soil . . . . . | |
| Zone **h**. | Sandy buff-coloured Coralline Crag (part of zone **g** reconstructed ?) . | 2′ 0″ to 3′ 0″ |
| „ **g**. | Buff to yellow Coralline Crag, "the rock bed," a soft friable building stone in three distinct beds, false-bedded throughout, full of Bryozoa and shell detritus | About 17′ 0″ to bottom of pit; base not seen. |

*Pit at Low Farm, Gedgrave*, close to the marshes, showing in part the downward succession of the High-House pit.

| | | |
|---|---|---|
| Zone **f**. | Yellow sandy Coralline Crag, of the usual characters, but even-bedded in part; full of Bryozoa and Mollusca . . . . | 3′ 6″ to 4′ 0″ |
| | Pale buff-coloured Coralline Crag, current-bedded; full of small Mollusca, *Erato*, *Raphitoma*, *Cæcum*, *Trivia*, *Eulima*, *Nucula*, *Psammobia*, *Lucinopsis*, &c., with many species of Foraminifera . . . | 3′ 0″ |
| | | Base not seen. |

A small pit at Ferry Barn, half a mile to the south-west, also shows a good exposure of this bed, with Foraminifera and small Mollusca.

*Zone* **f**.—This is rich in Foraminifera, some of the species being large and striking, *e. g. Textilaria agglutinans*, *T. gibbosa*, *Polymorphina variata*, *P. frondiformis*, *P. compressa*, *P. complanata*, together with large, but rarer, *Biloculina ringens*, &c. Speaking generally, the Foraminifera are closely allied to those

from Sutton, zone **f**. *Spirillina vivipara*, usually a rare species, is somewhat common here.

*Zone* **g**.—The most striking feature of this zone is the comparative abundance of *Lagenæ*, particularly the marginate forms. Other rather common species are *Nonionina scapha*, *Spirillina vivipara*, *Miliolina oblonga*, *Planorbulina mediterranensis*, *Textilaria sagittula*, *Bolivina Ænariensis*, and *Rotalia Beccarii*.

*Zone* **h**.—This has not been examined for Foraminifera, as it is in all probability part of zone **g** reconstructed.

7. Aldborough.—Zone **g**. The pits near the Red House, Leiston Road, close to Aldborough, show about eight feet of fine buff-coloured rubbly limestone full of Bryozoa, in part decalcified. Mollusca are not abundant, those species of which the tests are formed of aragonite having been removed by percolation of carbonated waters. *Chlamys opercularis* is abundant, however, as the shell consists of calcite.[1] Owing to this decalcification Foraminifera are somewhat scarce in this locality, only a few much decomposed Porcellaneous forms, such as *Miliolina oblonga*, *M. seminulum*, and *Biloculina ringens* occurring. The Hyaline forms, although better preserved, are usually in a somewhat decomposed condition, with the chambering obscured. The list, therefore, in all probability by no means represents the Foraminiferal fauna as originally existing.

8. Sudbourne.—Zone **g**. Pits to the north of Sudbourne Church.

The upper beds in this neighbourhood, nearly all referable to this zone, are highly ferruginous, and prove to be very poor in Foraminifera. Certain species are numerically plentiful, but all are difficult to determine, being coated with oxide of iron in such a manner as to render the chambers and sutures indistinct. The following is a complete list of species found after a long search :

1. *Polymorphina gibba*, m. R.
2. *Globigerina bulloides*, m. RC.
3. *Planorbulina mediterranensis*, m. R.
4. *Truncatulina Ungeriana*, s. RC.
5. — *lobatula*, m. VC.
6. — *variabilis*, m. VR.
7. *Pulvinulina repanda*, m. R.

[1] For an account of the experimental evidence obtained as to the cause of the inferior stability of aragonite fossils as compared with those formed of calcite, with special reference to the Foraminifera and Mollusca, see "On the Mineralogical Constitution of Calcareous Organisms," by V. Cornish and P. F. Kendall, 'Geol. Mag.,' new series, dec. 3, vol. v, 1888, pp. 66—73.

8. *Rotalia Beccarii*, s. R.
9. — *calcar*, m. RC.
10. *Polystomella crispa*, m. VC.
11. *Nonionina scapha*, m. VR.

LENHAM BEDS.—The sands and fossiliferous ironstone found at Lenham, in Kent, were referred by Prof. Prestwich[1] to the Crag. Later writers were inclined to consider the beds as of Eocene age ; but a careful re-examination and comparison of the fossils found in this ferruginous sandstone with those of Diestian age have led Mr. C. Reid to fully endorse the view that they are Pliocene; and he states,[2] "As the age of the deposits still seemed very uncertain, it was necessary, for the purpose of this Memoir, to re-examine the ironstones capping the Downs between Folkestone and Maidstone. The result of this examination was thoroughly to confirm Prof. Prestwich's view of the Pliocene age of the beds near Lenham."

The sand does not appear to have been examined for Foraminifera, and, as it has been entirely decalcified, it would probably give but a false conception of the protozoan life. The original scope of this Monograph, also, only extended to the consideration of the Foraminifera of the Crag deposits of the Eastern Counties; but all the English Pliocene beds have been here briefly touched upon to render the work as complete as possible.

THE NODULE-BEDS.—The nodule-beds have already been referred to in dealing with the sections at Sutton, where the zone **a** was originally exposed. Owing to the mixed and *remanié* character of the deposit in the exposures now open, such as Foxhall, no examination has been made for Foraminifera, as the inferences to be drawn from such as might be found, although interesting, might prove misleading.

[1] "On the Age of some Sands and Iron-sandstones on the North Downs," 'Quart. Journ. Geol. Soc.,' vol. xiv, 1858, pp. 322–3.

[2] "Pliocene Deposits of Britain," 'Mem. Geol. Surv.,' 1890, p. 44.

# III. DESCRIPTION OF THE SPECIES.

## I. PORCELLANEA *vel* IMPERFORATA.

*General Characters.*—Shells calcareous, imperforate, compact, and porcellaneous in structure; translucent and, when viewed by transmitted light, of a light brown colour.

### *Family* 1.—MILIOLIDÆ.

*General Characters.*—Shell-structure as above, or sometimes sandy, chitinous, or even siliceous.

#### *Sub-family* 1.—Miliolininæ.

*General Characters.*—Chambers two in each convolution, coiled on the long axis of the shell, either symmetrically on one plane or inequilaterally; so that two, three, five, or rarely more are visible externally. Aperture alternately at either end of the shell.

Of late years much earnest research has resulted in our having a better knowledge of this Agathistegian group.

In 1826, when revising the work of previous authors, Alcide D. d'Orbigny ('Ann. Sci. Nat.,' vol. vii, pp. 297—304) placed various forms which had been included by earlier observers in the generic terms *Miliola*, *Miliolites*, *Serpula*, *Vermiculum*, and *Lagena*, into six genera, which he called *Biloculina*, *Spiroloculina*, *Triloculina*, *Articulina*, *Quinqueloculina*, and *Adelosina*, concluding that the definite external segmentation of the test was of real generic importance.

In 1858, W. C. Williamson, in his 'Recent Foraminifera of Great Britain' (Ray Society), united three of the genera (*Triloculina*, *Quinqueloculina*, and *Adelosina*) under the one (new) name *Miliolina*. His chief ground for this amalgamation may be given in his own words:—"This genus differs from *Biloculina* and *Spiroloculina* in the circumstance that the convolutions, instead of being wound in one plane, continually alter their direction." At the same time he

pointed out that the chambers, whatever their convolutions, always retain a parallelism with the polar axis of the test; also "that all the characteristic features of these genera frequently occur in one and the same species;" nor did he consider a definite number of segments to be an essential feature in this consolidated genus (*Miliolina*).

In 1860, "*Miliola*" was used by Parker and Jones as a comprehensive generic term ('Ann. Mag. Nat. Hist.,' ser. 3, vol. v, p. 469); but, as Dr. H. B. Brady has explained ('Challenger' Report, 1884, pp. 137, 156, &c.), it is advisable to retain *Biloculina*, *Fabularia*, and *Spiroloculina* as separate genera, and to keep *Triloculina*, *Quinqueloculina*, and *Adelosina* grouped together under the name *Miliolina* given by Williamson. These four genera constitute the sub-family *Miliolininæ;* the other sub-families—*Nubecularinæ*, *Hauerininæ*, *Peneroplidinæ*, *Alveolininæ*, and *Keramosphærinæ*—completing the family *Miliolidæ*.

MM. Munier-Chalmas and C. Schlumberger, in their researches on the existence of two conditions of growth in many species of Foraminifera, as first indicated for Nummulites by Parker and Jones ('Ann. Mag. Nat. Hist.,' ser. 3, vol. viii, 1861, p. 233, and 'Catal. Foss. Foram. Brit. Mus.,' 1882, p. 93), also for Orbitoides ('Geol. Mag.,' vol. i, 1864, p. 103); and more fully studied by Ph. De la Harpe (see letter dated October 1st, 1879, 'Catal. Foss. Foram. Brit. Mus.,' 1882, pp. 91—93, and 'Mém. Soc. Pal. Suisse,' vol. vii, 1880–8, p. 63, &c.), discovered that such "twin forms," "couples," or "dimorphs" occur in other genera besides Nummulites.[1] These forms were classed in two groups; the one (A) with a large initial chamber (*megalosphere*), and the other (B) with a small initial chamber (*microsphere*).

Among the "*Miliolidæ*" they separated and defined, by means of carefully prepared internal sections, showing the relative size of the primordial chamber, and the arrangement and character of the segments of the test, the following forms:—*Biloculina*, *Dillina*, *Fabularia*, *Lacazina*, *Triloculina*, *Trillina*, *Quinqueloculina*, *Pentellina*, and *Heterillina*. Subsequently[2] *Idalina*, *Adelosina*, *Periloculina*, *Massilina*, *Spiroloculina*, and *Sigmoïlina;* besides others, as *Nodosaria*, *Dentalina*, *Cristellaria*, *Siphogenerina*, *Orbulina*, *Rotalina*, and *Amphistegina* (see E. Vanden Broeck, 'Bull. Soc. Belge Géol. Paléont. Hydrolog.,' vol. vii, 1893, pp. 6—41).

In 1884, H. B. Brady (in the 'Challenger' Report, pp. viii and ix) gave a

[1] 'Bull. Soc. Géol. France,' ser. 3, vol. viii, 1880, p. 300; 'Comptes Rendus,' vol. xcvi, 1883, pp. 862—866, and pp. 1598—1601; 'Ann. and Mag. Nat. Hist.,' ser. 3, vol. xi, 1883, pp. 340, 341.

[2] 'Assoc. Franç. Congrès Rochelle,' 1883, pp. 230—232; 'Congrès Rouen,' 1884, pp. 520—527; 'Bull. Soc. Géol. France,' ser. 3, vol. xii, 1884, pp. 629, 630; vol. xiii, 1885, pp. 273—323; vol. xv, 1887, pp. 573—584; 'Bull. Soc. Zool. France,' vol. xi, 1886, pp. 544—557; 'Mém. Soc. Zool. France,' vol. iv, 1891, pp. 542—578; vol. vi, 1893, pp. 57—80.

succinct account of dimorphism in the two different senses in which it had been applied by Rhizopodists from the time of d'Orbigny to that of Munier-Chalmas and Schlumberger.

The structural differences, among the *Miliolidæ* and others, discovered and illustrated by MM. Munier-Chalmas and Schlumberger are of very great interest, adding much to our knowledge of Foraminifera. They are often associated with external features sufficiently recognisable for the use of the trivial names already in vogue, and the zoological standing of the members of the group is not interfered with. Indeed, their mutual relationships have strong evidence in the new observations. Thus the structure of *Biloculina depressa*, form B, shows that this form passes through (1) a biloculine, (2) a triloculine, (3) a quinqueloculine, and (4) a biloculine stage in reaching completion; whilst *B. comata* has (1) a biloculine, (2) a quinqueloculine, (3) a quadriloculine, (4) a triloculine, and ultimately (5) a biloculine stage. *Adelosina*, after its unilocular form, has biloculine, triloculine, quadriloculine, and quinqueloculine stages. This is termed "initial polymorphism" by MM. M.-Chalmas and Schlumberger. Not only is the real generic value of *Miliolina* thus more firmly established, but it has a right to include *Biloculina* and *Spiroloculina* (as applied by Dr. A. Goës).[1]

M. Schlumberger states that in the *Biloculinæ* and *Triloculinæ* having a small initial chamber (the form B) the first chambers are as in *Quinqueloculina*; subsequent chambers take the arrangement that they have in the other form (A) of each of the two genera, namely, on two planes or surfaces of symmetry for *Biloculina*, and on three for *Triloculina*. He observes ('Bullet. Soc. Zool. France,' vol. xi, 1886, p. 557), "In the three species of *Adelosina* under notice, and in the three groups of *Biloculinæ* already mentioned, the form B presents a special character common to all the individuals of each of the groups. In the *Adelosinæ* this is a megasphere completely enveloped by the first chamber, which becomes lenticular. In the *Biloculinæ* it is the megasphere with two series of chambers on two planes of symmetry. I could cite also the *Triloculinæ* and the *Quinqueloculinæ*, in which the megasphere is encircled with three or with five series of chambers.

"In the form B of these four genera, on the contrary, the microsphere is always encircled with a cycle of five chambers; and this grouping is sometimes regularly or irregularly persistent, and sometimes it is differently arranged.

"I conclude, then, that, in the classification of the *Miliolidæ*, a megaspheric form (A) will determine the genus, and the microspheric (B) the species." He also mentions that many of the *Quinqueloculinæ* are of the genus *Adelosina*.

The thickening of the shell-walls in various degrees, forming labyrinthic interiors and cribriform apertures, already noticed in *Miliolidæ*, as in *Lituolidæ* and

[1] 'K. Svenska Vet.-Akad. Handl.,' vol. xix, No. 4, 1882, pp. 122—132.

other Foraminifera, has been further illustrated by MM. Munier-Chalmas and Schlumberger, whether it be formed by the outside of the chamber last invested or by a subsidiary shell-growth.

As the recognition of the separate species and varieties is, for general purposes, based on the external features of the test, and these are liable to a wide range of variability in individual growths, there is little need of altering the names as given in Part I of this Monograph, except with regard to *Triloculina* and *Quinqueloculina* (pp. 7—14), the necessity for which change the synonymy of *Miliolina oblonga* (pp. 7 and 8) sufficiently supports in the direction of the views above referred to.

The special biological value of the presence of either a *large* (A) or a *small* (B) initial chamber in any Foraminifer has been a chief subject of study by De la Harpe and other observers above mentioned, but definite results have not yet been arrived at.

Those Nummulites grouped under A are generally "free-growing individuals, soon arriving at their limit of growth" (P. and J., 1861); whereas the others (B) attain a larger relative size. This variation in the individuals of one species M. Munier-Chalmas at first (1880) termed "dimorphism," with a different application from that of *Dimorphina* (d'Orbigny, 1846), and "dimorphous" (P. and J., 1860), and "trimorphism" (P. and J., 1863), which have reference to successive stages from one style of growth to another. The later expositions, however, by Munier-Chalmas and his colleague of the growth of the *Miliolidæ* (as noticed above) may be said to give the term its full meaning as to the passage-forms in individuals altering their plan of growth, without reference to the primordial chamber. As the dimorphous forms of *Miliolina*, *Peneroplis*, *Lituola*, *Textilaria*, *Valvulina*, *Polymorphina*, and some of the *Nodosarinæ*, &c., though severally grouped under "generic" names,[1] are plainly referable to their zoological type-forms, so the *Miliolidæ* and allied groups still hold their suzerainty over the more or less differentiated forms, whether species, sub-species, or varieties, elucidated of late by the careful diagnoses elaborated by our esteemed fellow-workers in France (see a note on "Dimorphism" in the 'Annals and Mag. Nat. Hist. Soc.,' Ser. 6, vol. xiv, 1894, pages 401—407).

There is, of course, great difficulty in deciding the relative value of differences among individuals (of all the groups) showing modifications (often inconsiderable) or deviations from the zoological type, whether due to idiosyncrasy of the individual or to evolution among the many, for they may have been caused by accidents of

[1] Such as *Articulina, Spirolina, Haplophragmium, Bigenerina, Spiroplecta, Gaudryina, Clavulina, Amphicoryne, Flabellina, Marginulina, Dimorphina, Sagrina*, &c.

growth, or they may show ontogenetic variation, due to progression, or even to deterioration of the special form.

Although Foraminifera, like other organisms, should be classified on true morphological characters, we all know it is good that the differences of individual forms, and of limited groups of such varieties, should be carefully noted and made serviceable to collectors and systematists; and the only acceptable plan for the purpose is (as has often been said) to apply the usual nomenclatorial terms, without regarding them as of the same value as when applied to members of the groups of higher animals. Keeping this in mind, we are glad to use the results of the judicious and discriminative labours of MM. Munier-Chalmas and C. Schlumberger, as in the case of earlier rhizopodal workers, and to give full references to their descriptions and figures whenever fit opportunities occur.

Clear and important remarks on this subject have been given by Dr. A. Goës in the 'K. Svenska Vet.-Akad. Handl.,' vol. xix, No. 4, p. 7; and vol. xxv, No. 9, p. 5.

### *Genus* 1.—Biloculina, *d'Orbigny*, 1826.

Part I, 1866, page 4. Brady's Report 'Challenger,' 1884, p. 139.

*Characters.*—Chambers in one plane, embracing; the last two only visible.

We need not enlarge on the exact and philosophical treatment of this Foraminiferal type by Williamson (1858) and Brady (1884), nor repeat the general remarks published at pp. 4—6 of Part I. *Biloculina* multiplies itself in extremely variable and gradational forms; two of its most recognisable features are (1) the slit-like aperture of *B. ringens*, and (2) the more contracted and somewhat projecting aperture of *B. bulloides*.[1] The shape of the test varies from subglobose, with two faces of varying inequality, to disciform or oval (thick or thin), long-oval or subcylindric, &c., each shape claiming a separate name with many authors. On the external sculpturing and other ornaments, and sometimes on the constitution and consistency of the test, other names are based.

Of late the internal structure, so well studied by MM. Munier-Chalmas and Schlumberger, has enabled them to recognise a greater fixedness in some of the structural characters; indeed, these observers have been able to systematise as tangible species (if not genera) some forms regarded as varieties; at the same time we feel confident in relegating many of the "species," formerly so called, to mere varieties of a type or sub-type.

In the 'Svenska Vet.-Akad. Handl.,' vol. xix, 1882, pp. 131—134, Goës offers a

[1] See further on, p. 21.

classification of *Biloculinæ* founded on the external shapes, with illustrations in plate x; see also op. cit., vol. xxv, 1894, pp. 116—121.

In treating of *Biloculina bulloides* and *B. ringens* ('Bull. Soc. Géol. France,' 1887, p. 579, M. Schlumberger states that, from the study of the *Miliolidæ* by Signor Fornasini and himself, it is found that the Pliocene forms are much nearer to the existing forms than to those from the Eocene strata.

1. Biloculina ringens (*Lamarck*), 1804. Plate III, figs. 26, 27.

Part I, 1866, page 5; and Appendix II, Table, No. 3.

Some of the more important of later synonyms of *B. ringens* are—

Biloculina ringens, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 5, pl. iii, figs. 26, 27.

— antiqua, *Karrer*, 1867. Sitzungsb. Akad. Wiss. Wien, vol. lv, p. 365, pl. iii, fig. 7 (Jurassic).

— bulloides, var. calostoma, *Karrer*, 1868. Ibid., vol. lviii, p. 132, pl. i, fig. 4.

— anodonta, *Karrer*, 1868. Ibid., p. 133, pl. i, fig. 6.

— turgida, *Reuss*, 1870. Ibid., vol. lxii, p. 464; *Schlicht*, Pietzpuhl, 1870, pl. xxxv, figs. 27—29; and pl. xxxvi, figs. 1—3.

— caudata, *Reuss*, 1870. Ibid., vol. lxii, p. 464; *Schlicht*, Pietzpuhl, 1870, pls. xxxv, figs. 33—38.

— ringens (and varieties ?), *Terquem*, 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, p. 152, pl. xxiii, figs. 32—36.

Miliolina ringens, *Goës*, 1882. K. Svensk. Vet.-Akad. Handl., vol. xix, p. 131, pl. x, figs. 361, 362.

Biloculina ringens, *Brady*, 1884. Rept. 'Challenger,' p. 142 (with synonymy), pl. ii, figs. 7 and 8. (Brady's fig. 7 is Schlumberger's "*B. Bradyi*," and fig. 8 his "*B. vespertilio*," 1891, pl. ix, figs. 63—71, and 74—76.)

— — var., *Balkwill and Wright*, 1885. Trans. Roy. Irish Acad., vol. xxviii, p. 322, pl. xii, figs. 6, 7.

— — *Dawson*, 1886. Handbook of Zoology, p. 45, fig. 36.

— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 219.

— intermedia, *Fornasini*, 1886. Ibid., vol. v, p. 259, pl. iv, fig. 2; and pl. v, fig. 2.

— brachyodonta, *Fornasini*, 1886. Ibid., vol. v, p. 260, pl. iv, fig. 3; and pl. v, fig. 3.

— ringens, *Schlumberger*, 1887. Bull. Soc. Géol. Fr., ser. 3, vol. xv, p. 126, pl. xv, figs. 14—18; and woodcuts, figs. 6—9.

— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc. Lond., vol. xii, p. 213, pl. xl, figs. 19, 20.

MILIOLINA RINGENS, *Goës*, 1889. Bihang k. Svensk. Akad. Handl., vol. xv, part 4, No. 2, p. 14, pl. ii, figs. 7, 13, and 14.

BILOCULINA RINGENS, *Terrigi*, 1889. Atti R. Acc. Lincei Mem., ser. 4, vol. vi, p. 107, pl. iv, fig. 1.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, p. 220, pl. i, figs. 7—9.

— INTERMEDIA, *Fornasini*, 1893. Mem. R. Accad. Bologna, ser. 5, vol. iii, p. 440, pl. i, figs. 1, 1 *a*.

(NOTE.—In the reference to P. and J., 1857, in the synonymy given at p. 5 of Part I, figs. 32 and 33 should be omitted, being probably striated forms of *B. bulloides*.)

The aperture usually consists of a transverse slit, but varies in relative size and in the shape of the tongue-like valve, not only in those mentioned in the synonymy, but also in others, among which are several that have received from M. Schlumberger the specific names of *Bradyi* (*ringens*, Rep. 'Challenger,' p. 142, pl. ii, fig. 7), *vespertilio* (*ringens*, ibid., fig. 8), *Fischeri*, *Milne-Edwardsi*, *pisum*, *anomala ?*), in 'Mém. Soc. Zool. France,' vol. iv, pp. 166—182, pls. ix—xi, figs. 55, &c., and woodcuts. The *B. ringens*, Schlumb., 'Bull. Soc. Géol. France,' ser. 3, vol. xv, pl. xv, figs. 14—18, have subcircular apertures.

Goës unites with the typical *Biloculina* (*Miliolina*) *ringens* (figs. 7, 13, and 14, pl. ii, 'Bihang k. Svensk. Vet.-Ak. Handl.,' vol. xvi, part iv, No. 2) several varieties of triloculine growth.

Taking a group of *Biloculinæ* belonging to *B. ringens* as far as the transverse slit-like mouth is concerned (for example, some figured in d'Orbigny's 'Foram. Foss. Vienne,' 1846), we may notice that they vary from lenticular to subrotund and subovate, thus:

1. Lenticular, *B. lunula*, p. 264, pl. xv, figs. 22—24 [*B. depressa*].
2. Sublenticular, *B. affinis*, p. 265, pl. xvi, figs. 1—3.
3. Subrotund, *B. simplex*, p. 264, pl. xv, figs. 25—27.
4. Subovate, *B. clypeata*, p. 263, pl. xv, figs. 19—21.
5. Subpyriform, *B. inornata*, p. 266, pl. xvi, figs. 7—9.

The last (No. 5) has a contracted, subcircular, and slightly projecting aperture, thus approaching *B. bulloides*, with which we group it now as a variety.

An interesting group of *Biloculinæ* were figured (but not named nor described) by Dr. G. C. Wallich in 1862, "The North Atlantic Sea-bed," part i, pl. v, namely, fig. 1, *Biloculina ringens;* figs. 2, 5, and 8, *B. depressa;* figs. 3, 4, and 6, *B. bulloides*. They escaped notice in Part 1 of this Monograph, 1866, but are well worthy of attention. See also a group of *B. ringens* and varieties in Schlicht's 'Foram. Septar.-Thones Pietzpuhl,' 1870, pl. xxxv, figs. 27—29, 33—

35, 36—38, and pl. xxxvi, figs. 1—3, variously named by Reuss in the 'Sitzungsb. k. Ak. Wiss. Wien,' vol. lxii, 1870, page 464.

Another group, having its most globose form with a transverse aperture in a somewhat projecting mouth, passes into forms with more contracted aperture, thus resembling *B. inornata*, d'Orb., in the rounded and projecting aperture. These are shown in—

Biloculina bulloides, *d'Orb.*, var. truncata, *Reuss*, 1867. Sitzungsb. k. Akad. Wiss. Wien, vol. lv, p. 69, pl. ii, fig. 1.
— — — var. truncata-gracilis, *Reuss*. Ibid., fig. 2.
— larvata, *Reuss*, 1867. Ibid., vol. lv, p. 70, pl. ii, fig. 3. With this last form the following nearly corresponds:
— tenuis, *Karrer*, 1868. Ibid., vol. lviii, p. 133, pl. i, fig. 5.

As examples of differences we may remark that in pl. xv, 'Bull. Soc. Géol. France,' 1887, M. Schlumberger gives *B. ringens* (from the Paris Tertiaries) with a subcircular aperture, and *B. bulloides* (from Grignon) with a low subcircular aperture and a simply forked tongue.

*Occurrence.*—*Biloculina ringens* is common in every sea, and at all depths to nearly 3000 fathoms. It occurs in the Upper Jurassic (Karrer), and the Eocene of the Paris Basin. It is common in Tertiary formations generally. In the Coralline Crag of Sutton the species is not uncommon, and it occurs rarely in other exposures of the same formation and in the Red Crag.

2. Biloculina elongata, *d'Orbigny*, 1826. Plate III, fig. 28 (end view shows the aperture), and Plate VI, figs. 1 *a*, *b*. Part I, 1866, page 5, footnote.

Biloculina elongata, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 298.
Miliola (Biloculina) elongata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 409, pl. xvii, fig. 88 (not 90 and 91 = another var. of *B. bulloides*).
Biloculina elongata, *Parker, Jones, and Brady*, 1871. Ann. Mag. Nat. Hist., ser. 4, vol. viii, p. 247, pl. viii, fig. 6.
— — *Terquem*, 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, p. 154, pl. xvi (xxiv), fig. 1.
— — *Brady*, 1884. Report 'Challenger,' p. 144, pl. ii, fig. 9 (synonymy).
— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, pp. 218 (with synonymy) and 271.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, p. 214, pl. xl, figs. 21, 22.
Miliolina elongata, *Goës*, 1889. Bihang k. Svensk. Vet.-Akad. Handl., vol. xv, part 4, No. 2, p. 14, pl. ii, fig. 12.

Biloculina elongata, *Schlumberger*, 1891. Mém. Soc. Zool. France, vol. iv, p. 571, cuts 35, 36, pl. xi, figs. 87, 88; pl. xii, fig. 89. (Figs. 87—89 make a near approach to d'Orbigny's *B. inornata*, figs. 7—9, pl. xvi, For. Foss. Vien.)

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 308, 468, 469.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, Abtheil. ii, p. 220, pl. i, fig. 1.

— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 119, pl. xxiv, figs. 906—913.

*Characters.*—*Biloculina elongata* may be grouped with *B. ringens* as a narrow or contracted variety, subcylindrical or elongate-oval in shape, with its aperture more or less subcircular, and a somewhat modified epistomium.

*Occurrence.*—This form has a wide geographical distribution. It appears to be more common in the North Atlantic and South Pacific. In a fossil condition it has been recorded from the Eocene of Paris (Terquem), from the Miocene (?) of Muddy Creek, Victoria (Howchin), and from the Plaisancian (Older Pliocene) of Castellarquato. This species was recorded before only from the Red Crag; we now find it rarely, but of large size, in the pits of the Coralline Crag at Sudbourne Hall and Broom Hill, both in Zone **d**.

The following list is a classification of *Biloculina elongata* and its immediate allies, drawn up with great care, and kindly supplied by F. W. Millett, Esq., F.R.M.S.

I. Biloculina elongata with exposed portion of penultimate chamber not pyriform.

Frumentaria *Ovula*, *Soldani*, 1795. Testaceograph. vol. i, part 3, p. 228, pl. cliii, figs. M and Q.

Biloculina sacculus, *Terquem*, 1858. Mém. Ac. Imp. Metz, vol. xxxix, p. 636, pl. iv, fig. 15.

— ringens, *Terquem*, 1876. Foram. Dunkerque, p. 80, pl. x, fig. 21.

— elongata, *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, p. 154, pl. xxiv, fig. 1 (near *bulloides*).

— — *Brady*, 1884. Rept. 'Challenger,' p. 144, pl. ii, fig. 9.

— — *Goës*, 1894. K. Svensk. Ak. Handl., vol. xxv, p. 119, pl. xxiv, figs. 910, 911.

II. Biloculina elongata with exposed portion of penultimate chamber pyriform.

Frumentaria *milium*, *Soldani*, 1795. Testaceograph. vol. i, part 3, p. 231, pl. clvi, fig. *vv*.

Biloculina opposita, *Deshayes*, 1831. Descr. Coq. Caract., p. 259, pl. iii, figs. 8—10.

— Bougainvillei, *d'Orbigny*, 1839. Foram. Amérique Mérid., p. 67, pl. viii, figs. 22—24.

— Patagonica, *d'Orbigny*. Ibid., p. 65, pl. iii, figs. 15, 17.

— oblonga, *d'Orbigny*, 1839. Foram. Cuba, p. 163, pl. viii, figs. 21—23.

— inornata, *d'Orbigny*, 1846. Foram. Foss. Vien., p. 266, pl. xvi, figs. 7—9.

— appendiculata, *Eichwald*. Leth. Ross., p. 11, pl. i, fig. 12 (near *inornata*).

— ringens, var. Patagonica, *Williamson*, 1857. Rec. For. Brit., p. 80, pl. vii, figs. 175, 176.

— elongata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 409, pl. xvii, figs. 90, 91.

— bulloides, var. truncato-gracilis, *Reuss*, 1867. Sitz. Akad. Wiss. Wien, vol. lv, Abth. 1, p. 68, pl. ii, fig. 2.

— larvata, *Reuss*, 1867. Ibid., p. 70, pl. ii, fig. 3.

— tenuis, *Karrer*, 1868. Ibid., vol. lviii, Abth. 1, p. 133, pl. i, fig. 5.

— ringens, *Chimmo*, 1870. Bed of the Atlantic, p. 27, pl. x, fig. *a*.

— (indet.), *Chimmo*, 1878. Nat. Hist. Euplectella, pl. vi, fig. 21.

— elongata, *Fornasini*, 1891. For. Plioc. Ponticello, pl. ii, fig. 2.

— — *Schlumberger*, 1891. Mém. Soc. Zool. Fr., vol. iv, p. 184, pl. xi, figs. 87, 88; and pl. xii, fig. 89, and figs. 35, 36, p. 184.

III. Other Biloculinæ with the exposed portion of penultimate chamber pyriform.

Near *sphæra*.

Biloculina Grinzingensis, *Karrer*, 1877. Abhandl. k.-k. geol. Reichs., vol. ix, p. 375, pl. 16 *a*, fig. 8.

Near *irregularis*.

Biloculina ventruosa, *Reuss*, 1867. Sitz. k. Ak. Wiss. Wien, vol. lv, Abth. 1, p. 69, pl. i, fig. 9.

Between *depressa* and *ringens*.

Biloculina Isabelleana, *d'Orb.*, 1839. Foram. Amériq. Mérid., p. 66, pl. viii, figs. 17—19.

Between *bulloides* and *ringens*.

Biloculina lævis, *Goës*, 1894. K. Svensk. Vet.-Ak. Handl., vol. xxv, No. 9, p. 119, pl. xxiv, figs. 914, 915.

Near *ringens*.

Biloculina bulloides, var. truncata, *Reuss*, 1867. Sitz. k. Ak. Wiss. Wien, vol. lv, Abth. 1, p. 68, pl. ii, fig. 1.

— cf. elongata, *Fornasini*, 1891. For. plioc. Ponticello, pl. ii, fig. 1.

Near *bulloides*.

Biloculina Peruviana, *d'Orb.*, 1839. Foram. Amériq. Mérid., p. 68, pl. ix, figs. 1—3.

— constricta, *Costa*, 1856. Atti Accad. Pont., vol. vii, fasc. 2, p. 301, pl. xxiv, fig. 2.

— liasica, *Zwingli and Kubler*, 1870. Foram. Schweiz. Jura, p. 7, pl. i, Turnerithon, fig. 18.

— ringens, *G. M. Dawson*, 1870. Canadian Naturalist, n. s., vol. v, p. 8, fig. 8.

— bulloides, *Brady*, 1884. 'Challenger' Rept., p. 142, pl. ii, fig. 5.

— tubulosa, *Brady*, 1884. Ibid., p. 147, pl. iii, fig. 6.

— larvata, var. ventricosa, *Mariani*, 1888. Atti Soc. Ital. Sci., vol. xxxi, p. 94, pl. xxxi, fig. 1.

Miliolina ringens, *Goës*, 1889. Bihang k. Svensk. Vet.-Ak. Handl., vol. xx, part 4, No. 2, p. 14, pl. ii, fig. 10.

Biloculina elongata, *Goës*, 1894. K. Svensk. Vet.-Ak. Handl., vol. xxv, No. 9, p. 119, pl. xxiv, figs. 910, 911.

3. Biloculina depressa, *d'Orbigny*, 1826. Plate III, figs. 29, 30, and Pl. V, fig. 1. Part I, 1866, page 6; and Appendix II, Table, No. 5.

*Additional Synonyms:*

Biloculina depressa, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 298; Modèle, 91.

Miliola (Biloculina) depressa, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 409, pl. xvii, fig. 89.

Biloculina depressa, *Parker, Jones, and Brady*, 1865. Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 33, pl. i, fig. 4.

— — *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 6, pl. iii, figs. 29, 30.

— scutella, *Karrer*, 1868. Sitzungsb. k. Akad. Wiss. Wien, vol. lviii, p. 134, pl. i, fig. 7.

— depressa, *Karrer*, 1877. Abhandl. k. k. Geol. Reichst., vol. ix, p. 374, pl. 16*a*, fig. 7.

Biloculina depressa, *Munier-Chalmas and Schlumberger*, 1883. Compt. Rend., vol. xcvi, p. 864, figs. 1 and 2; and Ann. Mag. Nat. Hist., ser. 5, vol. xi, p. 338, figs. 1 and 2; and 1885, Bull. Soc. Géol. France, ser. 3, vol. xiii, pp. 278, 280, figs. 4, 5, and 5 bis.

— — *Schlumberger*, 1884. Assoc. Sci. France, Congrès Rouen, 1883, pp. 522—525, figs. 3—8.

— — *Brady*, 1884. Report "Challenger," p. 145 (with synonymy), pl. ii, figs. 12, 15—17; pl. iii, figs. 1, 2 (Brady's fig. 15 is Fornasini's "*B. Bradyi*," Boll. Soc. Geol. Ital., vol. v, 1886, p. 261).

— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 261.

— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, p. 213, pl. xl, figs. 17, 18.

Miliolina depressa, *Goës*, 1889. Bihang k. Svensk. Vet.-Akad. Handl., vol. xv, part 4, No. 2, p. 14, pl. ii, figs. 15, 16.

Biloculina depressa, *Schlumberger*, 1891. Mém. Soc. Zool. France, vol. iv, p. 547, cuts 1—5, pl. ix, figs. 48, 49.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, abth. 2, p. 220, pl. i, figs. 4—6.

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 17, 178, 179, 307.

— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 120, pl. xxv, figs. 921—925.

*Characters.*—This is essentially a depressed variety of *B. ringens*, having its opposite faces much less convex than in the type. The chambers become flattened at the edge into a keel, which is often exaggerated into a broad, thin lamina,[1] sometimes crenulate.[2]

Some depressed *Biloculinæ* have the aperture somewhat contracted, and in this respect approach *B. bulloides*. Brady's figs. 15 and 16, in pl. ii, Rep. 'Chall.,' show such passage-forms.

*Occurrence.*—*Biloculina depressa.*—The geographical range of this species is co-extensive with that of *B. ringens*. Geologically it occurs in the Eocene, London Clay and Bracklesham Beds, in the Miocene of Vienna and Muddy Creek, Victoria, in the Diestian and Casterlian of Antwerp, and in the Tertiaries of Malaga and Piedmont. In addition to the occurrence at Sutton recorded in Part I of this Monograph, we find this species, but rarely, at Broom Hill (zone **d**).

[1] As Williamson's *B. ringens*, var. *carinata*, figs. 172—174, p. 79, 'Rec. Br. Foram.,' 1858.

[2] As Goës's *M. ringens*, pl. x, fig. 361, p. 131, 'Svensk. Akad.,' 1882.

Biloculina bulloides, *d'Orbigny*, 1826. Var. inornata, *d'Orb.*, 1846. Plate VII, figs. 1 *a*, *b*, *c*.

*Characters.*—The specimen under notice appears to be a suboval variety of *B. bulloides*, with a somewhat circular aperture situated in a slightly produced neck; corresponding with—

Biloculina inornata, *d'Orb.*, 1846. Foram. Foss. Bass. Tert. Vienne, p. 266, pl. xvi, figs. 7—9.

— bulloides, var. truncata-gracilis, *Reuss*, 1867. Sitz. k. Akad. Wiss. Wien, vol. lv, p. 69, pl. ii, fig. 2 (named on the plate).

— tenuis ?, *Karrer*, 1868. Ibid., vol. lviii, p. 133, pl. i, fig. 5.

Var. *inornata* is also closely allied to *B. elongata*, for the latter often has the exposed portion of the penultimate chamber pear-shaped; and there are few of those bearing that character that would not be assigned to *elongata*.

To complete the series of typical *Biloculinæ* referred to at page 93, we here add a brief synonymy of *B. bulloides*, d'Orb.

Biloculina bulloides, *Terquem* (after *d'Orbigny*), 1882. Mém. Soc. Géol. France, sér. 3, vol. ii, p. 153, pl. xxiii, fig. 38.

Miliolina ringens, *Goës*, 1882. K. Svenska Akad. Handl., vol. xix, p. 131, pl. x, figs. 363—365, 386 ?.

Biloculina bulloides, *Brady*, 1884. 'Challenger' Rept., p. 142, pl. ii, figs. 5, 6 (= *lucernula*, Schlumb., 1891).

— — *Fritel*, 1886. Foss. Caract. Terr. Séd., pl. 7, figs. 68, 69.

— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 219 (with synonyms).

— — *idem*, 1886. Ibid., vol. v, p. 257, pl. iv, fig. 1; pl. v, fig. 1.

— — *idem*, 1887. Ibid., vol. vi, fasc. 1, p. 12 (with synonyms).

— — *Schlumberger*, 1887. Bull. Soc. Géol. Fr., sér. 3, vol. xv, pp. 574—579, pl. 15, figs. 10—13, and woodcuts 1—5.

Miliolina ringens, *Goës*, 1889. Bihang till k. Svenska Vet.-Akad. Handl., vol. xv, p. 14, pl. ii, fig. 10.

Biloculina lucernula, *Schlumberger*, 1891. Mém. Soc. Zool. Fr., vol. iv, p. 185, pl. 12, figs. 90—96, and woodcuts figs. 37—41.

— bulloides, *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, Abth. 2, p. 217, pl. i, figs. 16—18.

— — } and their allies, *Goës*, 1894. K. Svensk. Akad. Handl.,
— ringens, } vol. xxv, No. 9, pp. 116—119.

M. Schlumberger does not admit Signor Fornasini's pl. v, fig. 1 (quoted above), to be a true *B. bulloides* ('Bull. Soc. Géol. France,' 1887, p. 574), on account of some difference of internal structure. In referring (loc. cit.) to the confusion of the species (*B. bulloides* and *B. ringens*), he rightly blames the often indifferent figures and imperfect descriptions given by former writers, as well as the dearth of information about the internal structure. Another reason, however, for this apparent confusion is that the classifications of Foraminifera have been based on the existence of zoological type-forms (whether generic or specific), the other forms having been grouped more or less closely with them. Thus *Biloculina ringens* was taken as one Milioline type, and *M. seminulum* as another by Parker and Jones (1857, 1860, &c.), by Williamson (1858), by Goës (1882), by Brady (1884). Consequently great latitude of opinion has arisen on the subject of the relationship of these almost interminably gradational, and often isomorphous forms. Similarly this holds good to a great extent among the members of the genus *Nodosarina* proposed by Parker and Jones. The differentiation of internal structures, as shown by MM. Munier-Chalmas and Schlumberger, and the researches carried on now-a-days in the life-history of some of the Foraminifera,[1] raise hopes of a better distinction of forms, and of a more perfect classification.

*Occurrence.*—The typical *Biloculina bulloides* is recorded as common in the North Atlantic, but more rarely in other latitudes; and it has a wide bathymetrical range. It is a common Tertiary fossil. The var. *inornata* has been found in the Miocene of Vienna, the Tertiaries of Piedmont, and the Diestian and Scaldisian of Antwerp. In the Crag we find it, small and very rare, at Sudbourne Hall, Gedgrave, and Sutton.

### *Genus* 2.—Spiroloculina, *d'Orbigny*, 1826.

Part[2] I, 1866, page 15.

D'Orbigny, 'Foram. Foss. Tert. Vienne,' 1846, p. 268; Brady, Report 'Challenger,' 1884, p. 147; Egger, 'Abhandl. k. Bayer. Akad.,' 1893, vol. xxviii, Abth. 2, p. 221.

*General Characters.*—Chambers opposite, alternate, in one plane; all visible on both sides (faces) of the shell.

For convenience it is found best to arrange the more common *Spiroloculinæ* in six groups according to certain features which are recognisable in different

[1] See also J. J. Lister's "Contributions to the Life-history of the Foraminifera," 'Proc. Roy. Soc.,' vol. lvi, No. 337, 1894, pp. 155—160.

[2] In the last line but one of the synonyms at p. 15 *read* p. 470 *instead of* p. 466.

examples, though subject to modification and interchange. Thus :—1. Those that have the surfaces of the chambers flat (planulate). 2. The surfaces of the chambers sloping down towards the centre of the shell (excavate). 3. The outer margin or periphery channelled, being bordered by two limbate edges (canaliculate). 4. The chambers bordered by raised lines or ridges (limbate). 5. Chambers convex on surface (rotundate). 6 & 7. Other forms, not here dealt with, either (6) have the surfaces of their chambers raised and ridged (angulate) ; or (7) have them sunken and concave (hollow-chambered).

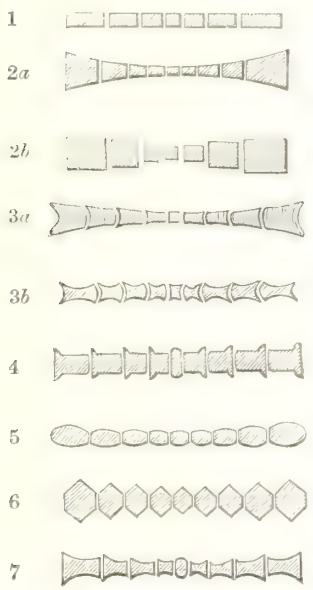


Fig. 1.—*Spiroloculina planulata* (Lam.). Diagram representing a transverse section of the flat whorls of the shell.

Figs. 2 *a*, 2 *b*.—*Spiroloculina excavata*, d'Orb. Diagrams showing the surfaces of the whorls (*a*) sloping inwards on each surface to the hollow centre of the shell ; and (*b*) sinking by steps into the hollow of the centre.

Figs. 3 *a*, 3 *b*.—*Spiroloculina canaliculata*, d'Orb. Diagrams showing the concave (channelled) outer margin of the whorls ; in Fig. 3 *b* the surface-margins of the chambers are somewhat limbate.

Fig. 4.—*Spiroloculina dorsata*, Reuss. Diagram of a transverse section of the whorls with superficial shell-growth at the outer margin of each whorl, marking the sutures of each face.

Fig. 5.—*Spiroloculina nitida*, d'Orb. Diagram showing the convex surfaces of the whorls.

Fig. 6.—*Spiroloculina*, section of, with whorls having an angular surface.

Fig. 7.—*Spiroloculina*, section of, with the whorls concave on the exterior surfaces.

1. Spiroloculina planulata (*Lamarck*), 1804. Pl. III, figs. 37, 38 ; Woodcut, fig. 1. Part I, 1866, page 15 ; and Appendix II, Table No. 15.

Miliolites planulata, *Lamarck*, 1804. Ann. Mus., vol. v, p. 352 ; 1822, Anim. sans Vert., vol. vii, p. 612 (three varieties are indicated by Lamarck).

Spiroloculina depressa, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 298, No. 1 ; Modèle, No. 92 ; Parker, Jones, and Brady, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 33, pl. i, fig. 6 ; and ser. 4, vol. viii, 1871, p. 248, pl. viii, fig. 23 ; referred to *Sp. planulata*.

— perforata, *Bronn*, 1838. Lethæa Geognostica, p. 1143, pl. xlii, fig. 33.

— Badenensis, *d'Orbigny*, 1846. Foram. Foss. Vien., p. 270, pl. xvi, figs. 13—15.

— dilatata, *d'Orbigny*, 1846. Ibid., p. 271, pl. xvi, figs. 16—18.

Spiroloculina Sandbergeri, *Reuss*, 1853. Neues Jahrb. für Min., p. 671, pl. ix, fig. 2 (rather concave in the middle).

— planulata, *Parker and Jones*, 1860. Ann. Mag. Nat. Hist., ser. 3, vol. v, p. 470.

— excavata, *Brady*, 1865. Nat. Hist. Trans. Northumb. and Durham, vol. i, p. 93, pl. xii, fig. 1.

Miliola (Spiroloculina) planulata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 408, pl. xvii, fig. 82.

Spiroloculina planulata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 15, pl. iii, figs. 37, 38.

— compressiuscula, *Karrer*, 1867. Sitz. k. Akad. Wiss. Wien, vol. lv, p. 258, pl. ii, fig. 4.

— depressa, *Terquem* (after *d'Orbigny*), 1878. Mém. Soc. Géol. France, sér. 3, vol. i, p. 54, pl. x, fig. 11. This seems to agree with Soldani's figure chosen by d'Orbigny for his "*depressa*" (see Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 33, 1865), but that was already the *planulata* of Lamarck.

— dilatata, *Terquem*, 1881. Plage Dunkerque, fasc. 3, p. 133, pl. xvii, fig. 13.

— planulata, *Brady*, 1884. 'Challenger' Rept., p. 148, pl. ix, fig. 11.

— depressa, *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 221, No. 295.

— papyracea, *Burrows, Sherborn, and Bailey*, 1890. Journ. Roy. Microsc. Soc., vol. for 1890, p. 551, pl. viii, fig. 1 (thin variety).

— ? depressa,[1] *Schlumberger*, 1893. Mém. Soc. Zool. France, vol. vi, p. 202, pl. iii, fig. 69, and woodcut, fig. 2.

— planulata (?), *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 19, 178, 179.

— cf. planulata, *Idem*, 1893. Ibid., p. 309.

*Characters.*—Lateral surfaces of the chambers plane and parallel to the axis of the shell; shell sometimes slightly concave; periphery usually flat and square; the surfaces of the chambers are sometimes slightly concave. Lamarck indicated three forms of his *Miliolites planulata*, namely: $\alpha$, the typical *planulata*; $\beta$, less flattened, var. *turgidula*; and $\gamma$, thin and keeled, *planissima* (see 'Ann. Mag. Nat. Hist.,' ser. 3, vol. v, 1860, p. 470). The second of these perhaps may have corresponded with the form named by Williamson *Spiroloculina depressa*, var. *rotundata* ('Rec. Brit. For.,' 1858, p. 82, fig. 178), and probably with *Sp. nitida*, d'Orb. ('Ann. Mag. Nat. Hist.,' ser. 4, vol. viii, 1871, p. 248, pl. viii, fig. 24), and *Sp. rotunda*,[2] d'Orb. (ibid., fig. 25), excepting as to the shape of outline. The name

[1] The section given at p. 202 is that of *M. excavata*.

[2] Not *rotundata*, as printed loc. cit.

"*turgidula*" would have been applicable if we knew the specimen, but for those varieties having more or less convex chambers we must take "*nitida*"—d'Orbigny's earliest name. The flat-chambered forms, however, remain as *Sp. planulata*, whether oval or round in outline, and whether square or rounded on the margin or even slightly channelled, as in our Pl. III, figs. 37, 38. They are very liable to vary in relative thickness. Some specimens become somewhat concave by a step-like arrangement of the flat chambers rising one higher than the other during the growth of the shell.

Other varieties of *Sp. planulata* have the surfaces of the chambers slightly concave, such as are well shown in *Sp. Badenensis*, d'Orb., and *Sp. dilatata*, d'Orb. These, moreover, being somewhat concave in the middle, are evidently passage-forms leading to *Sp. excavata*, d'Orb.

The following have the chambers slightly hollowed, the shell, however, remaining flat: *Sp. cretacea*, Reuss, and *Sp. compressiuscula*, Karrer.

Some of the *planulata*-group forms are very thin (such as the *compressiuscula*, K., and *papyracea*, B. S. B.). Of the flat-chambered forms our figs. 37 and 38, in Pl. III, represent an extreme example (with slightly fluted margin), but are well matched in Brady's Report 'Challenger,' pl. ix, fig. 11 (with plane margin).

*Occurrence.*—As a shallow-water form *Spiroloculina planulata* has a wide geographical range in temperate latitudes. It has been recorded as a fossil from the London Clay, the Calcaire grossier of the Paris basin, the Miocene of Vienna, and the Tertiaries of Palermo. In the Crag it has been found at Sutton only. In the First Part of this Monograph it is stated to occur commonly there; but in our material we have not been able to find a single specimen from Sutton or elsewhere.

Mr. Millett observes that—

Spiroloculinæ having plane chambers with ornamented surfaces are—

Spiroloculina costigera, *Terquem*, 1882. Mém. Soc. Géol. Fr., sér. 3, vol. ii, p. 159, pl. xxiv, fig. 24.

— pertusa, *Terquem*, 1882. Ibid., sér. 3, vol. ii, p. 160, pl. xxiv, fig. 27.

— semiornata, *Terquem*, 1882. Ibid., sér. 3, vol. ii, p. 161, pl. xxiv, fig. 28.

2. Spiroloculina excavata, *d'Orbigny*, 1846. Plate V, fig. 2; Woodcuts, figs. 2 *a*, 2 *b*.

Spiroloculina excavata, *d'Orbigny*, 1846. Foram. Foss. Vienne, p. 271, pl. xvi, figs. 19, 20.
— (not named), *Costa*, 1838. Fauna Regno Napoli, pl. ii, fig. 2.
— excavata, *Costa*, 1856. Atti Accad. Pontan., vol. vii, fasc. 2, p. 311, pl. xxiv, fig. 11.
— depressa, var. rotundata, *Williamson*, 1857. Rec. Brit. Fos., p. 82, pl. vii, fig. 178.
— Freyeri, *Reuss*, 1864. Denks. k. Akad. Wiss. Wien, vol. xxiii, p. 6, pl. i, fig. 9.
— excavata, *Brady*, 1865. Nat. Hist. Trans. Northumb. and Durham, vol. ii, part 1, p. 93, pl. xii, fig. 1.
— cavernosa, *Karrer*, 1867. Sitz. k. Ak. Wiss. Wien, vol. lv, Abth. 1, p. 358, pl. ii, fig. 3.
— excavata, *Terquem*, 1875. Plage Dunkerque, fasc. 1, p. 38, pl. v, fig. 17.
— angulosa, *Terquem* (after *d'Orbigny*), 1878. Mém. Soc. Géol. Fr., sér. 3, vol. i, p. 53, pl. x, fig. 7.
— crassa, *Seguenza*, 1880. Mem. R. Accad. Lincei, ser. 3, vol. vi, p. 152, pl. xiv, fig. 10.
— (indet.), *Carpenter*. Introd. Foram., 1862, pl. vi, fig. 1; re-figured in Schlumberger's Feuill. Jeun. Nat. Année xii, 1882, p. 29, pl. ii, fig. 4. Apparently excavate, with slightly concave chambers.
— cf. bicarinata, *Schwager*, 1883. Palæontographica, vol. xxx, p. 85, pl. i, fig. 4.
excavata, *Brady*, 1884. 'Challenger' Rept., p. 151, pl. ix, figs. 5, 6.
— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 238, No. 368.
— limbata, *Chapman*, 1892. Quart. Journ. Geol. Soc., vol. xlviii, p. 516, pl. xv, fig. 4.
— excavata, *Egger*, 1893. Abhandl. k. Bayer. Akad., cl. ii, vol. xviii pp. 219, 223, pl. i, figs. 44, 45.
— — *Schlumberger*, 1893. Mém. Soc. Zool. Fr., vol. vi, p. 201, fig. 1; and pl. iii, fig. 68.
— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 20, 178, 179, 310.
— Soldanii, *Fornasini*, 1894. Foram. Coll. Soldani (Sagg. Oritt.), p. 20, pl. o, fig. 1.

*Characters.*—Lateral surfaces of the chambers plane or hollowed, and inclined to the axis of the shell, either by a uniform slope or by steps, so that it

is sunken in the centre and biconcave; sutures sometimes limbate; edges thick, and the margins plane, or nearly so.

In this form the chambers gradually increase in thickness from the first to the last, so that the inner or central part of the test is hollow and thin, and the outer is thick, with more or less projecting edges.

Our form, Pl. V, fig. 2, is very similar to d'Orbigny's representation of the Vienna fossil. Some specimens are more oval and produced at the ends.

As in other cases, some confusion has arisen about the "species," which is essentially a biconcave variety of *Spiroloc. planulata.*

Of three figures given by Soldani, 'Testaceogr.,' vol. ii, 1798, pl. xix, figs. *l*, *m*, *n* (p. 54, Frumentaria *Sigma et Rhombos*), d'Orbigny chose one (fig. *m*) for his *Spiroloculina limbata* ('Ann. Sci. Nat.,' vol. vii, 1826, p. 299, No. 12). This is a nearly oval *Spiroloculina*, with the outer chambers apparently rounded, and one of them much inflated; the centre is concave. No limbation is shown. This shell is noticed in the 'Ann. Mag. Nat. Hist.,' ser. 4, vol. viii, 1871, p. 248, No. 141, pl. 8, fig. 22, by Parker, Jones, and Brady, as "a bold variety [of *Spiroloculina planulata*] with inflated chambers." The figure there given unfortunately does not express the convexity or roundedness of the outer margin of the chambers, but makes them flat and sharp-edged. If all the chambers had a definitely convex surface, this shell would be allied to the *Sp. nitida* and *rotunda*, d'Orb. As it is, the fig. *m* may be referred to *Sp. excavata.*

Of the two other figures, fig. *l* is oval and concave, with flat chambers; and fig. *n* is like it, but of a narrow-oval outline. These two correspond sufficiently well with *Sp. excavata*, as figured by d'Orbigny, 'Foram. Foss. Vien.,' 1846, p. 271, pl. xvi, figs. 19—21. Fig. *m* is rightly referred by Signor C. Fornasini, 'Bollett. Soc. Geol. Italiana,' vol. v, 1886, p. 238, No. 368, to *Sp. excavata*, d'Orb., but we should think, if Soldani's drawing be true, as a *sub-variety* (such as *inæqualis*) of that form.

*Occurrence.*—*Spiroloculina excavata* has its home in comparatively shallow water; and it is, for the most part, confined to tropical and the warmer temperate seas. Fossil specimens are recorded from the London Clay of Sheppey, the Miocene of Vienna, the Pliocene (?) of Italy, and the Pliocene Clay of St. Erth. In the Crag we find it at Sutton and Broom Hill.

3. Spiroloculina canaliculata, *d'Orbigny*, 1846. Plate III, figs. 39, 40; Woodcuts, figs. 3 *a*, 3 *b*.

Part I, 1866, page 16; and Appendix II, Table, No. 16.

Spiroloculina cymbium, *d'Orb.*, 1839. Hist. Nat. Canaries, p. 140, pl. iii, figs. 5, 6.
— canaliculata, *d'Orb.*, 1846. Foram. Foss. Vienne, p. 269, pl. xvi, figs. 10—12.
— — *Costa*, 1856. Atti Accad. Pontan., vol. vii, fasc. 2, p. 312, pl. xxiv, fig. 10.
— — var., *Costa*, 1856. Ibid., fig. 9.
— *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 16, pl. iii, figs. 39, 40.
— depressa, *Terquem*, 1878. Mém. Soc. Géol. France, ser. 3, vol. i, p. 54, pl. x, fig. 11.
— canaliculata, *Terquem*, 1881. Plage Dunkerque, fasc. 3, p. 133, pl. xvii, fig. 12.
— limbata, var., *Brady*, 1884. Report 'Challenger,' p. 150, pl. x, figs. 1, 2.
— planulata, *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, p. 214, pl. xl, figs. 14, 15.
— canaliculata, *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., cl. ii, vol. xviii, pp. 218, 224, pl. i, figs. 40, 41.
— impressa, *Egger*, 1893. Ibid., figs. 35, 36.
— — cfr. bicarinata, *d'Orb.*,[1] *Schwager*, 1883. Palæontographica, vol. xxx, p. 85, pl. xxiv, fig. 4.
— depressa, *d'Orbigny*
— perforata, *d'Orbigny*
— Grateloupi, *d'Orbigny*
— bicarinata, *d'Orbigny*

For notes on these forms see p. 35.

*Characters.*—Lateral surfaces of the chambers plane, with or without limbate sutures; the peripheral margin channelled; centre usually somewhat concave.

The gradational differences of the test, due to greater or less amount of shell-growth along the edges of the chambers, give rise to some confusion in the classification of the noticeable varieties. If the exogenous or extra shell-growth predominates on the edges of the periphery, it makes a channel along the outer margin. This feature characterises d'Orbigny's well-shaped *Spiroloculina canali-*

[1] As defined by Terquem, 'Mém. Soc. Géol. Fr.,' ser. 3, vol. ii, 1882, p. 155, pl. xxiv, fig. 5.

*culata*, as well as the less compact and weaker *Sp. cymbium*, and other forms named by him at an earlier date, in 1826.

If the exogenous shell-matter is strong at the sutures of the chambers, there forming vertical lines or ridges on the two lateral surfaces or faces of the shell, we have the *Sp. dorsata*, Reuss, *Sp. limbata*, Bornemann, *Sp. impressa*, Terquem, and some others ; but if the two marginal edges are widened out horizontally, the shell has a canaliculate periphery.

This characteristic marginal fluting seems to serve as a useful criterion ; and in Part I, page 16, it was used as such, and *Sp. canaliculata* was chosen as the subtype. The above list of synonyms excludes the forms that have square (plane) margins ; but several of the varieties have some modification as well in this respect as in sutural limbation, central concavity, and general outline. Indeed, in our fig. 40 the marginal furrow is very feebly developed ; even stronger in fig. 38. In the latter the planulate character predominates ; in the former, as a marginal channel is formed by limbation of its edges, the limbation of the sutures is here of minor consideration.

The following remarks on some canaliculate *Spiroloculinæ* that have been variously named will show how the minor features are modified, and how complicated the nomenclature has become.

(1) Spiroloculina depressa, *d'Orb*, 1826 (' Ann. Sci. Nat.,' vol. vii, p. 298, No. 1), according to Terquem, 1878 (' Mém. Soc. Géol. France,' ser. 3, vol. i, art. 3, p. 54, pl. x, fig. 11, from d'Orbigny's unedited drawing, pl. i, fig. 1), is *canaliculate* and limbate, hollow-chambered, and slightly excavate (not Williamson's fig. 177, which has an angulate margin) ; but the *Model* No. 92 having been taken for the type and criterion in 1865 and 1871, it is best to adhere to the conclusion then arrived at of its being *planulata*.

(2) Spiroloculina perforata, *d'Orb.*, 1826 (' Ann. Sci. Nat.,' vol. vii, p. 298, No. 2 (" Modèles, No. 92," is a misprint) ), according to Terquem, 1882 (' Mém. Soc. Géol. France,' ser. 3, vol. ii, art. 3, p. 154, pl. xxiv, figs. 3 and 4 (? *Ophthalmidium*), after d'Orbigny's unedited drawing, pl. i, fig. 2), is *canaliculate*, limbate, excavate, and narrow.

(3) Spiroloculina Grateloupi, *d'Orb.*, 1826 (' Ann. Sci. Nat.,' vol. vii, p. 298, No. 3), according to Terquem, 1878 (' Mém. Soc. Géol. France,' ser. 3, vol, i, art. 3, p. 52, pl. x, fig. 5 ; and var. fig. 6, after d'Orbigny's unedited drawings, pl. i, figs. 9—11 ; and in ' Mém. Soc. Géol. France,' ser. 3, vol. ii, art. 3, p. 155, pl. xxiv, fig. 6), is *broadly channelled* on margin (*canaliculate*) and limbate.

3. Spiroloculina canaliculata, *d'Orbigny*, 1846. Plate III, figs. 39, 40; Woodcuts, figs. 3 *a*, 3 *b*

Part I, 1866, page 16; and Appendix II, Table, No. 16.

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— — var., *Costa*, 1856. Ibid., fig. 9.
— *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 16, pl. iii, figs. 39, 40.
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— canaliculata, *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., cl. ii, vol. xviii, pp. 218, 224, pl. i, figs. 40, 41.
— impressa, *Egger*, 1893. Ibid., figs. 35, 36.
— — cfr. bicarinata, *d'Orb.*,[1] *Schwager*, 1883. Palæontographica, vol. xxx, p. 85, pl. xxiv, fig. 4.
— depressa, *d'Orbigny*
— perforata, *d'Orbigny*
— Grateloupi, *d'Orbigny*
— bicarinata, *d'Orbigny*

For notes on these forms see p. 35.

*Characters.*—Lateral surfaces of the chambers plane, with or without limbate sutures; the peripheral margin channelled; centre usually somewhat concave.

The gradational differences of the test, due to greater or less amount of shell-growth along the edges of the chambers, give rise to some confusion in the classification of the noticeable varieties. If the exogenous or extra shell-growth predominates on the edges of the periphery, it makes a channel along the outer margin. This feature characterises d'Orbigny's well-shaped *Spiroloculina canali-*

[1] As defined by Terquem, 'Mém. Soc. Géol. Fr.,' ser. 3, vol. ii, 1882, p. 155, pl. xxiv, fig. 5.

*culata*, as well as the less compact and weaker *Sp. cymbium*, and other forms named by him at an earlier date, in 1826.

If the exogenous shell-matter is strong at the sutures of the chambers, there forming vertical lines or ridges on the two lateral surfaces or faces of the shell, we have the *Sp. dorsata*, Reuss, *Sp. limbata*, Bornemann, *Sp. impressa*, Terquem, and some others ; but if the two marginal edges are widened out horizontally, the shell has a canaliculate periphery.

This characteristic marginal fluting seems to serve as a useful criterion ; and in Part I, page 16, it was used as such, and *Sp. canaliculata* was chosen as the subtype. The above list of synonyms excludes the forms that have square (plane) margins ; but several of the varieties have some modification as well in this respect as in sutural limbation, central concavity, and general outline. Indeed, in our fig. 40 the marginal furrow is very feebly developed ; even stronger in fig. 38. In the latter the planulate character predominates ; in the former, as a marginal channel is formed by limbation of its edges, the limbation of the sutures is here of minor consideration.

The following remarks on some canaliculate *Spiroloculinæ* that have been variously named will show how the minor features are modified, and how complicated the nomenclature has become.

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(3) Spiroloculina Grateloupi, *d'Orb.*, 1826 (' Ann. Sci. Nat.,' vol. vii, p. 298, No. 3), according to Terquem, 1878 (' Mém. Soc. Géol. France,' ser. 3, vol, i, art. 3, p. 52, pl. x, fig. 5 ; and var. fig. 6, after d'Orbigny's unedited drawings, pl. i, figs. 9—11 ; and in ' Mém. Soc. Géol. France,' ser. 3, vol. ii, art. 3, p. 155, pl. xxiv, fig. 6), is *broadly channelled* on margin (*canaliculate*) and limbate.

(4) Spiroloculina bicarinata, *d'Orb.*, 1826 ('Ann. Sci. Nat.,' vol. vii, p. 298, No. 6), according to Terquem, 1882 ('Mém. Soc. Géol. France,' ser. 3, vol. ii, art. 3, p. 155, pl. xxiv, fig. 5, after d'Orbigny's unedited drawings, pl. i, figs. 1—5), is a neat, small, narrow, *canaliculate* form.

It is evident from *plannlata* and *excavata* having sometimes limbate sutures and channelled margin, and *canaliculata* losing its marginal fluting and becoming a flat-edged *dorsata*, that it is really artificial distinctions that separate the forms, and that the leading character in each may be used in this arrangement.

*Occurrence.*—Recent specimens of *Spiroloculina canaliculata* are not uncommon in the Mediterranean in shallow and moderately deep waters. No specimens are recorded from the 'Challenger' dredgings. As a fossil, *Sp. canaliculata* is recorded from the Plaisancian beds of Piedmont, and from the Miocene of Vienna and Malaga. In the Crag it has been found at Sutton.

4. Spiroloculina dorsata, *Reuss*, 1866. Woodcuts, figs. 4 and 8 *a*, 8 *b*.

Spiroloculina cretacea, *Reuss*, 1854. Denksch. k. Akad. Wien, vol. vii, Abth. 1, p. 72, pl. xxvi, fig. 9.

— limbata, *Bornemann*, 1855. Zeitsch. Deutsch. Geol. Gesell., vol. vii, p. 348, pl. xix, fig. 1.

— depressa, *Williamson*, 1857. Rec. Brit. Foram., p. 82, pl. vii, fig. 177. A variety, not square and flat, but angular at the periphery.

— — var. cymbium, *Williamson*, 1857. Ibid., p. 82, pl. vii, fig. 179.

— limbata, *Reuss*, 1863. Sitzungsb. k. Akad. Wiss. Wien, vol. xlviii, p. 64, pl viii, fig. 89.

— Morloti, *Reuss*, 1864. Denksch. k. Akad. Wiss. Wien, vol. xxiii, p. 6, pl. i, fig. 10.

Miliola (Spiroloculina) limbata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 409, pl. xvii, fig. 83. (Periphery not quite square, but slightly concave.)

Spiroloculina dorsata, *Reuss*, 1866. Denksch. k. Akad. Wien, vol. xxv, p. 123.

— "cfr. limbata, *Bornemann*," *Hantken*, 1875. Mitth. Jahrb. k. Ungar. Geol. Anstalt, vol. iv, p. 20, pl. xiii, fig. 2.

— depressa, *Terquem*, 1875. Anim. plage Dunkerque, p. 38, pl. v, fig. 18.

— impressa, *Terquem*, 1878. Mém. Soc. Géol. Fr., ser. 3, vol. ii, art. 3, p. 53, pl. x, fig. 8.

— limbata, *Brady*, 1884. Rep. 'Chall.,' p. 150, pl. ix, figs. 15—17.

SPIROLOCULINA SOLDANII, *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, pp. 183, 185, Nos. 46, 156, 157; and 1894, Coll. Soldani, &c.,[1] pp. 20 and 31, pl. 1, figs. 1, 1 *a*.

— LIMBATA (?) = DORSATA, *de Amicis*, 1893. Ibid., vol. xii, fasc. 3, pp. 20, 178, 179.

— cfr. LIMBATA, *d'Orb.*, *de Amicis*, 1893. Ibid., vol. xii, p. 310.

— PLANULATA, *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, p. 107, pl. xviii, figs. 836, 836 *a*. A variety of *dorsata*, inclining to *canaliculata*.

— — — 1894. Ibid., vol. xxv, p. 107, pl. xviii, figs. 836 *b*, 836 *c*.

— LIMBATA, *Goës*, 1894. Ibid., figs. 837 and 837 *a*.

*Characters*.—Sutures limbate, periphery plane, somewhat concave. Other limbate forms are the narrow and almost excavate *Sp. Lapugyensis* and *cavernosa*, Karrer, 1867 ('Sitzb. Ak. Wien,' vol. lv, pp. 357, 358, pl. ii, figs. 2 and 3).

Von Reuss, in 1866, replaced Bornemann's appellation "*limbata*" by "*dorsata*," because d'Orbigny had already used the former. As the name *dorsata* has been applied by Reuss to two figures representing *Spiroloculina canaliculata* and *Sp. excavata* in von Schlicht's 'Foram. Septarienthones Pietzpuhl,' 1870, pl. xxxvii, figs. 27—32, possibly he regarded these as synonyms.

FIGS. 8 *a*, 8 *b*.—*Spiroloculina dorsata*, Reuss. *a*. View of the complete test, with its limbate sutures. *b*. Edge view from the oral end, showing the square periphery. × 15 (After Brady, 'Challenger' Report, pl. ix, figs. 17 *a*, *b*.)

The name *dorsata* seems to be more applicable to *canaliculata*: and Reuss may have associated the limbate and channelled forms, as was done in Part I of this Monograph, 1866, p. 16. The two together might be diagnosed thus: margins of the chambers more or less limbate, with the shell-growth either marking the sutures, or thickening the outer margins only, and thus fluting the periphery; centre of shell somewhat hollow.

In *Spiroloculinæ* having the surfaces of the chambers hollowed or concave there is usually some amount of either sutural or marginal limbation, which causes

[1] C. Fornasini, 'I Foraminiferi della Collezione Soldani relativa al "Saggio Orittografico," esistente nel Museo Paleontologico del R. Istituto di Studi Superiori in Firenze; con una Tavola,' 8vo., Bologna, 1894, p. 32.

the modification of the planulate form. In other words, those with concave chambers are mostly divisible into either *canaliculata*, d'Orb., or *dorsata*, Reuss.

*Occurrence.*—*Spiroloculina dorsata* (*limbata*, Bornemann) occurs rather commonly in all the great oceans, as well as in the Mediterranean and Red Seas, in depths not exceeding 400 fathoms. Fossil specimens are recorded from the Miocene of Vienna and Muddy Creek (Victoria), the Oligocene of Hermsdorf, and the Pliocene of Garrucha (South Spain) and St. Erth. In the Crag we find it in every locality examined, except Aldborough.

5. Spiroloculina nitida, *d'Orbigny*, 1826. Variety with a keel. Plate V, fig. 3; Woodcut, fig. 6.

Spiroloculina nitida, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 298, No. 4 (Soldani, vol. i, part 3, p. 229, pl. clv, figs. *ll*, *mm*?). Acute oval variety.

— rotunda,[1] *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 299, No. 14 (Soldani, vol. i, part 3, p. 229, pl. cliv, fig. *hh*). Circular variety.

— nitida, *Terquem* (after d'Orbigny's unedited drawings), 1878. Mém. Soc. Géol. France, ser. 3, vol. i, art. 3, p. 52, pl. x, fig. 4 (chambers narrow); and 1882, vol. ii, art. 3, p. 157, pl. xxiv, fig. 16 (outside chambers large).

— rotunda, *Terquem* (after d'Orbigny's unedited drawings), 1878 Ibid., ser. 3, vol. i, art. 3, p. 54, pl. x. fig. 10. Rather thicker than Soldani's figures quoted by d'Orbigny.

— No. 556, *von Schlicht*, 1870. Foram. Septar. Pietzpuhl, p. 98, pl. xxxvii, figs. 30—32 (variety).

— nitida, *Parker, Jones, and Brady*, 1871. Ann. Mag. Nat. Hist., ser. 4, vol. viii, p. 248, No. 140, pl. viii, fig. 24.

— rotundata, *Parker, Jones, and Brady*, 1871. Ibid., No. 142, pl. viii, fig. 25.

— infra-oolithica, *Terquem*, 1874. Foram. Syst. Oolith., p. 323, pls. xxxiv and xxxv, figs. 1—12.

— intorta, *Terquem*, 1874. Ibid., p. 325, pl. xxxv, figs. 9, 10.

— vermiformis, *Terquem*, 1874. Ibid., fig. 8.

[1] The name "*rotunda*" is preferable in one respect, but *nitida* (the oval form) came first in d'Orbigny's naming.

Spiroloculina sp. indet., *Hantken*, 1875. Mitth. Jahrb. k. Ung. Geol. Anstalt, vol. iv, p. 20, pl. xiii, fig. 1.

— rotunda, *Terquem*, 1878. Mém. Soc. Géol. Fr., ser. 3, vol. i, p. 54, pl. x, fig. 10.

— interrupta, *Terquem*, 1878. Ibid., p. 53, pl. x, fig. 9.

— ampla, *Terquem*, 1881. Plage Dunkerque, fasc. 3, p. 132, pl. xvii, fig. 10.

— desertorum, *Schwager*, 1883. Palæontographica, vol. xxx, p. 84, pl. xxiv, fig. 2. (*Sp. rotunda* with imperfect keel.)

— proboscidea, *Schwager*, 1883. Ibid., fig. 3. (Long oval *rotunda*, with very slight keel).

tenuiseptata, *Brady*, 1884. Rept. 'Challenger,' p. 153, pl. x, figs. 5, 6 (variety).

— rotundata, *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 220, No. 294.

— nitida, *Fornasini*, 1886. Ibid., vol. v, p. 221, No. 296 (with synonyms).

— Michalskii, *Wisniowski*, 1890. Mem. Acad. Sci. Cracow (Pamiet. Wydz. III, Akad. Umiej. Krak.), vol. xvii, p. 8, pl. viii, fig. 6.

— minima, *Wisniowski*, 1890. Ibid., p. 9, pl. viii, fig. 7.

— difficilis, *Wisniowski*, 1890. Ibid., p. 10, pl. viii, fig. 8.

— nitida, *Mariani*, 1891. Boll. Soc. Geol. Ital., vol. x, p. 171, pl. vi, fig. 1.

— tenuiseptata, *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., cl. ii, vol. xviii, pp. 218 and 223, pl. i, figs. 48, 49.

— (ophthalmidium ?) complanata, *Egger*, 1893. Ibid., p. 225, pl. iii, figs. 7, 8.

*Characters.*—Chambers convex; shell more or less biconcave; in some cases limbate.

The relationship of this form to *Spiroloculina planulata* has been explained above at p. 104; and reasons are there given why "*nitida*," d'Orb., is chosen instead of "*turgidula*," given by Lamarck to a similar variety, but which we cannot identify.

In the specimen before us (Pl. V, fig. 3) we have a boldly elliptical, or broad-oval, Spiroloculine shell with convex chambers and a distinctly limbate string-course or keel along the outer edge of the last two.

It nearly corresponds with pl. x, figs. 1 and 2, of Brady's *Spiroloculina limbata*, var., pp. 150, 151, Rep. 'Challenger,' 1884. This is a thin subcircular form, in which all the successive outer or over-riding chambers appear to have had the limbate edge. Hence Dr. Brady associated his specimen with Bornemann's

*limbata*, pointing out that that author had published a good limbate form, and that this name, as generally used, was applied by d'Orbigny to an unsatisfactory specimen of a different kind figured by Soldani (see above, p. 33). He also indicated that the chambers are not at all depressed as in Bornemann's figures, and in the limbate form of "*depressa*" figured by Williamson ('Recent. Brit. Foram.,' p. 82, fig. 177).

Following the artificial grouping explained at page 103, we see that the *Spiroloculina* shown by Pl. V, fig. 3, is not *planulata*, for it has not flat, but somewhat convex or slightly turgid, chambers; nor are they hollowed or depressed along their length, as is usual in *canaliculata* and *dorsata*. Whether or no the outer margins of the earlier chambers were limbate (those edges being now covered up) need not affect the question of the relationship of this from the Crag, and the other from the 'Challenger' dredgings. Had Dr. Brady given a name to his specimens we should have adopted it. It is evidently a limbate subvariety of *nitida*, d'Orb., which is a subtype or variety of the type *Spiroloculina planulata* (Lamarck).

The form under notice has some allies in Terquem's *Spiroloculina angulifera*, 'Mém. Soc. Géol. France,' ser. 3, vol. ii, p. 156, pl. xxiv, figs. 11 and 12 (with their associates among figs. 10—15); and *Sp. alata* (in part), ibid., p. 158, pl. xxiv, fig. 18. Schwager's *Sp. desertorum* and *proboscidea* were very near allies to our fig. 3.

*Occurrence.*—*Spiroloculina nitida.* This varietal form of *Sp. planulata* is common in tropical waters and in the Mediterranean. It has been noticed fossil in the Jurassic (Terquem), the Cretaceous (Wizniowski), and the Tertiaries of Hungary, Germany, Italy, and France. In the Crag it has been found only at Sutton.

Note.—(1) Mr. Millett has enumerated in the following lists several other forms of *Spiroloculina*. Some of these are characterised by the *chambers being angular on the exterior surface.* Of these the best type, in his opinion, is *Sp. acutimargo*, Brady.

Spiroloculina Poeyanana, *d'Orbigny*, 1839. Foram. Cuba, p. 168, pl. x, figs. 1, 2.
— ornata, *d'Orbigny*, 1839. Ibid., p. 167, pl. xii, fig. 7.
— tenuirostra, *Karrer*, 1867. Sitz. k. Akad. Wiss. Wien, vol. lv, Abth. 1, p. 358, pl. ii, fig. 5.
— disparilis?, *Terquem*, 1878. Mém. Soc. Géol. Fr., ser. 3, vol. i, p. 55, pl. x, fig. 12.
— affixa, *Terquem*, 1878. Ibid., fig. 13.
— angulosa, *Terquem*, 1881. Plage Dunkerque, fasc. 3, p. 132, pl. xvii, fig. 9.
— laminata, *Terquem*, 1881. Ibid., p. 133, pl. xvii, fig. 11.

Spiroloculina robusta, *Brady*, 1884. 'Challenger' Rept., p. 150, pl. ix, figs. 7, 8.
— acutimargo, *Brady*, 1884. Ibid., p. 154, pl. x, figs. 12—15.
— — *Balkwill and Wright*, 1885. Trans. Roy. Irish Acad., vol. xxviii, p. 323, fig. 1.
— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., cl. ii, vol. xviii, p. 222, pl. i, figs. 26—28.
— lamella, *Egger*, 1893. Ibid., p. 223, pl. i, figs. 24, 25.

(2) Mr. Millett also indicates others having the *whorls externally concave*, like figs. 39 and 40 in our Plate III.

Miliola concentrica, *Brown*, 1844. Illustr. Rec. Conch. Gt. Brit., p. 3, pl. lvi, fig. 22.
Spiroloculina panda, *Schwager*, 1865. Württ. Naturwiss. Jahreshefte, Jahrg. 21, p. 95, pl. ii, fig. 6.
— canaliculata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 16, pl. iii, figs. 39 and 40.
— No. 555, *v. Schlicht*, 1870. Foram. Pietzpuhl, p. 98, pl. xxxvii, figs. 27—29 ("*Sp. dorsata*," Reuss).
— angulosa, *Terquem*, 1878. Mém. Soc. Géol. Fr., ser. 3, vol. i, No. 3, p. 53, pl. v (x), fig. 7.
— canaliculata, *Vine*, 1878. Science Gossip, vol. xiv, p. 53, fig. 37.
— crassa, *Seguenza*, 1880. Atti R. Accad. Lincei, ser. 3, vol. vi, p. 152, pl. xiv, fig. 10.
— excavata, *Schlumberger*, 1893. Mém. Soc. Zool. Fr., vol. vi, p. 201, pl. iii, fig. 68; and fig. 1, p. 201.
— depressa, *Schlumberger*, 1893. Ibid., p. 202, pl. iii, fig. 69; and fig. 2, p. 202.
— inæquilateralis, *Schlumberger*, 1893. Ibid., pl. iv, figs. 84—86; and fig. 3, p. 202.

(3) Also others that have their *chambers externally concave* together with *limbate sutures* or *striate surface*.

Spiroloculina excavata, *Costa*, 1856. Atti Accad. Pont., vol. vii, fasc. 2, p. 311, pl. xxiv, fig. 11.
— striatella, *Reuss*, 1864. Denks. k. Akad. Wiss. Wien, vol. xxiii, p. 7, pl. i, fig. 8.
— depressa, *Terquem*, 1875. Plage Dunkerque, fasc. 1, p. 38, pl. v, fig. 18.
— impressa, *Terquem*, 1878. Mém. Soc. Géol. Fr., ser. 3, vol. i, No. 3, p. 53, pl. x, fig. 8.
— Grateloupi, *Terquem*, 1878. Ibid., p. 52, pl. v (x), fig. 5.
— — *Idem*, 1882. Ibid., vol. ii, p. 155, pl. xxiv, fig. 6.
— bicarinata, *Terquem*, 1882. Ibid., fig. 5.

SPIROLOCULINA IMPRESSA,[1] *Brady*, 1884. 'Challenger' Report, p. 151, pl. x, figs. 3, 4.
— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., cl. ii, vol. xviii, p. 224, pl. i, figs. 35, 36.

(4) Besides the *Spiroloculinæ* enumerated with foregoing lists, Mr. Millett observes that there are many which agree with some of the others in certain respects as regards the shape of the whorls, but are variously ornamented, and therefore worthy of separate consideration. Some also are arenaceous.

There remain some others which do not readily fall into this classification.

## *Genus* 3.—MILIOLINA, *Williamson*, 1858.

Part I, 1866, page 4 (*Miliola*, Lamarck, 1804). See also Brady, Report 'Challenger,' 1884, pp. 156—182.

*General Characters.*—Originally intended by Williamson to comprise the three forms—*Triloculina*, *Quinqueloculina*, and *Adelosina*—we still find it convenient to retain *Miliolina* on account of the close relationship found to exist between these forms as to both external and internal characters. The interesting peculiarities of their structure, as elaborated by MM. Munier-Chalmas and Schlumberger, are alluded to in some detail above at pages 91, 92.

### 1. MILIOLINA SEMINULUM (*Linné*). Plate III, figs. 35, 36.

Part I, 1866, page 9; and Appendix II, Table, No. 9.

*Additional Synonyms:*

QUINQUELOCULINA SEMINULUM, *J., P., and B.*, 1866. Monogr. For. Crag., p. 9, No. 1, pl. iii, figs. 35, 36.
MILIOLINA SEMINULUM, *Hartwig*, 1866. The Sea, 3rd edit., p. 381, fig. *g*.
— — *Cooke*, 1869. Thous. Objects Micr., p. 93, pl. ix, fig. 21.
— — *Chimmo*, 1870. Bed of Atlantic, p. 19, pl. iv, fig. 2.
— — *Greene*, 1871. Manual Protozoa, p. 15, fig. 3, *g*.

[1] *Spiroloculina impressa*, with the outer margin channelled, comes also under the quasi-specific group of *Sp. canaliculata* (see p. 108), thus furnishing a striking example of the intercommunity of Foraminiferal forms; so also our Pl. III, figs. 39, 40, referred to above. Other instances of one "species" showing the characteristics of another may be pointed out.

QUINQUELOCULINA SEMILUNUM [SEMINULUM], *Terquem*, 1875. Anim. plage Dunkerque, fasc. 1, p. 40, pl. vi, fig. 8.

MILIOLA (QUINQUELOCULINA) SEMINULUM, *Jones*, 1878. In Dixon's Geol. Sussex, 2nd edit., p. 172, pl. x, fig. 9.

QUINQUELOCULINA PLANA, *Terquem* (after *d'Orbigny*), 1878. Mém. Soc. Géol., France, ser. 3, vol. i, No. 3, p. 63, pl. vi (xi), figs. 6 *a*, *b*, *c*.

— VULGARIS, *Terquem* (after *d'Orbigny*), 1878. Ibid., p. 66, pl. xi, figs. 20 *a*, *b*, *c*, and 21.

MILIOLINA SEMINULUM (and varieties), *Goës*, 1882. K. Svenska Vet.-Akad. Handl., vol. xix, part 4, pp. 122—130.

— — *Brady*, 1884. Report 'Challenger,' pp. 157—160 (with cuts, figs. 3 *a*, *b*, *c*), pl. v, fig. 6.

— — *Sherborn and Chapman*, 1886. Journ. Roy. Microsc. Soc., ser. 2, vol. vi, p. 742, pl. xiv, fig. 1.

— — *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, p. 217.

— — *Fornasini*, 1887. Ibid., vol. vi, fasc. 1, pp. 11 (with synonyms) and 13.

— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 214, pl. xl, figs. 23, 31.

— — *Anon.* [*Chapman*], 1888. Scient. News, 1888, p. 389, fig. 5.

— — *Terrigi*, 1889. Mem. R. Accad. Lincei, vol. vi, p. 103, pl. iv, figs. 2, 3, 4, 11, 12.

QUINQUELOCULINA VULGARIS, *Fornasini*, 1893. Mem. R. Accad. Bologna, ser. 5, vol. iii, p. 439, pl. i, figs. 2, 2 *a*, 2 *b*.

— — *Schlumberger*, 1893. Mém. Soc. Zool. France, vol. vi, p. 65, figs. 13, 14, pl. ii, figs. 65, 66. Round form like fig. 3 *c*, p. 159, Rep. 'Challenger.'

— SEMINULUM, *Schlumberger*, 1893. Ibid., vol. vi, p. 66, figs. 15, 16, pl. iv, figs. 80, 81. Oval form like fig. 3 *a*, p. 159, Rep. 'Chall.'

MILIOLINA SEMINULUM, *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 25, 178, 179, 315—317.

QUINQUELOCULINA SEMINULUM, *Fornasini*, 1894. Foram. Coll. Soldani, Sagg. Oritt., p. 20.

*Characters.*—In the 'Kongl. Svenska Vetenskap-Akad. Handlingar,' vol. x, No. 4, 1882, Dr. A. Goës has given an illustrated synopsis of the principal varieties of the Foraminifera obtained from the Caribbean Sea, limiting himself to the consideration of true species, and not recognising merely stages and accidents of growth as the basis for distinctions. At pages 122 and 123 *Miliolina seminulum* (Linné) is taken as the central type for the following

varieties :—*scapha*, d'Orb.; *triangularis*, d'Orb.; *trigonula*, Lamarck; *agglutinans*, d'Orb.; *pulchella*, d'Orb.; *Brongniartii*, d'Orb. At pages 124—130 he groups numerous forms of the above (shown in his plates xi and xii) by the chief external characters.

In 1894, in the same Swedish Academy Transactions, vol. xxiv, Dr. Goës treats of *Miliolina seminulum* and its allies at pages 108—112.

It is not necessary here to add to the description of this Foraminifer given by Parker and Jones in the 'Annals and Mag. Nat. Hist.,' ser. 2, vol. xix, 1857, p. 300; and by Williamson, 'Recent Brit. Foram.,' 1858, pp. 85—87, or to the remarks already made in Part I, 1866, and by Goës in 1882, and Brady in 1884. The additional synonyms above quoted show how frequently this Foraminifer has been met with and more or less studied by naturalists.

*Occurrence.*—*Miliolina seminulum* has a world-wide range, and occurs at all depths to 3000 fathoms. Geologically it occurs in every deposit from the Lower Eocene upwards.

2. Miliolina triangularis (*d'Orbigny*). Plate IV, fig. 1; Plate VI, figs. 2 *a*, 2 *b*.

Part I, 1866, page 10; and Appendix II, Table, No. 8.

*Additional Synonyms:*

Quinqueloculina triangularis, *J., P., and B.*, 1866. Monogr. For. Crag, p. 10, No. 2, pl. iv, fig. 1.

— — *Terquem* (after *d'Orbigny*), 1878. Mém. Soc. Géol. France, ser. 3, vol. i, No. 3, p. 67, pl. viii (xii), figs. 1—9.

Triloculina triquetra, *Terquem*, 1882. Ibid., vol. ii, No. 3, p. 164, pl. xvi (xxiv), figs. 36, 37.

Miliolina triangularis (var. of M. seminulum), *Brady*, 1884. Report 'Challenger,' p. 157.

*Characters.*—This appears to be one of the large and trihedral recognisable varieties of the *Miliolina seminulum*, so changeable in its aspect according to the variable evolution of its chambers. As such it seems advisable to keep it distinct in this Monograph. It is more oval in the lateral aspect, and more triangular in its end view, than the smaller *M. subrotunda*—a near ally.

*Occurrence.*—There is a difficulty in settling the mutual synonymy of this form and *M. tricarinata;* and the occurrences mentioned for *M. triangularis* in Part I may be regarded as sufficient.

3. Miliolina Cuvieriana (*d'Orbigny*). Plate VI, figs. 3 *a*, 3 *b*.

Quinqueloculina Cuvieriana, *d'Orbigny*, 1839. Foram. Cuba, p. 190, pl. xi, figs. 19—21.
— Lamarckiana, *d'Orbigny*. Ibid., p. 189, pl. xi, figs. 14, 15.
Miliolina Cuvieriana, *Brady*, 1884. Report 'Challenger,' p. 162, pl. v, figs. 12 *a*, *b*, *c*.

*Characters.*—This form shows five angles in its end view; the weaker individual figured by d'Orbigny as *Lamarckiana* has only four projecting chambers (l. c., fig. 15). Thus both differ from *M. triangularis* so far as the relative protrusion of the chambers is concerned, but not essentially otherwise.

*Occurrence.*—*Miliolina Cuvieriana* is essentially a shallow-water form. The type-specimens were obtained by d'Orbigny from the shores of Cuba and Jamaica. Those mentioned in the 'Challenger' Report are from Japan, the Eastern Archipelago, and the Philippine Islands, and were found at depths ranging from six to ninety-five fathoms. As a fossil this species apparently occurs rarely. It has lately been found in the Miocene of Muddy Creek (Victoria); and the Crag specimens were obtained from Gomer (Gedgrave).

4. Miliolina tricarinata (*d'Orbigny*). Plate III, figs. 33, 34.

Part I, 1866, page 7; and Appendix II, Table, No. 6.

*Additional Synonyms:*

Triloculina tricarinata, *J., P., and B.*, 1866. Monogr. For. Crag., p. 7, No. 1, pl. iii, figs. 33, 34.
— angularis, *Terquem* (after *d'Orbigny*), 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, No. 3, p. 163, pl. xvi (xxiv), figs. 34, 35.
Miliolina tricarinata, *Brady*, 1884. Report 'Challenger,' p. 165, pl. iii, fig. 17.
— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 30, 178, 179, 320.
— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 114, pl. xxi, figs. 866—869.
Triloculina tricarinata, *Fornasini*, 1894. Foram. Coll. Soldani, Sagg. Oritt., p. 20.

*Characters.*—A distinct and usually symmetrical Triloculine *Miliolina*.

*Occurrence.*—*Miliolina tricarinata* is found in all seas and at all depths. Until Mr. Chapman's recent researches in the Gault of Folkestone its occurrence in a

fossil state was not recorded lower than the Tertiary. From the latter deposits specimens have been noted from the Calcaire Grossier of the Paris Basin, London Clay, Miocene of Muddy Creek, Australia, Italian Pliocene (de Amicis), and the St. Erth Clay (Millett). In the Crag it has been met with only at Sutton, and there rarely.

5. Miliolina oblonga (*Montagu*). Plate III, figs. 31, 32; and Plate V, fig. 5.

Part I, 1866, page 7; and Appendix II, Table, No. 7.

*Additional Synonyms :*

Triloculina (Quinqueloculina) oblonga, *J., P., and B.*, 1866. Monogr. For. Crag., p. 7, No. 2, pl. iii, figs. 31, 32.
— oblonga, *Terquem*, 1875. Plage Dunkerque, p. 38, pl. v, fig. 19.
Quinqueloculina oblonga, *Terquem*, 1875, Ibid., p. 40, pl. vi, fig. 10; and 1876, ibid., p. 85, pl. xii, figs. 6 *a*, *b*.
Triloculina oblonga, *Terquem*, 1878. Mém. Soc. Géol. France, ser. 3, vol. i, p. 58, pl. v (x), figs. 22—24.
Miliolina oblonga, *Brady*, 1884. Report 'Challenger,' p. 160, pl. v, fig. 4.
— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 27, 178, 179, 317.
— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 110, pl. xx, figs. 850, 850*f*.

*Characters.*—This Milioline form, usually showing three, but sometimes five faces, is nevertheless one of the most persistent in shape among the allied varieties of the type *seminulum*.

*Occurrence.*—*Miliolina oblonga* is found in all seas and at all depths, but the finest specimens come from the shallower waters of the temperate zones. As a fossil it has been recorded from the Upper Chalk of Taplow, the London Clay, the Miocene of Muddy Creek, the Pliocene of St. Erth and Italy. In the Crag it is a common Foraminifer in nearly every zone examined.

6. Miliolina subrotunda (*Montagu*). Woodcut, fig. 9.

Part I, 1866, page 11; and Appendix II, Table, No. 10.

*Additional Synonyms :*

Quinqueloculina subrotunda, *J., P., and B.*, 1866. Monogr. For. Crag, p. 11, No. 3.
— — *Terquem*, 1875. Plage Dunkerq., p. 39, pl. vi, fig. 4.

Miliolina subrotunda, *Brady*, 1884. Report 'Challenger,' p. 168, pl. v, figs. 10 and 11.

— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 109, pl. xix, figs. 846—847 *h*. With synonyms.

*Characters.*—This variable but sufficiently recognisable form was mentioned in Part I, p. 11, as having occurred in the Crag at Sutton, but lost before it could be drawn. A figure of another specimen is now given.

Fig. 9.—*Miliolina subrotunda*; magn. 50 diam. (After Brady, 'Challenger' Report, pl. v, fig. 11.)

*Occurrence.*—*Miliolina subrotunda* is essentially a shallow-water form. It is recorded from the Arctic Seas (Parker and Jones), from several localities in the Atlantic, and from the French and English coasts. Geologically it occurs in the Miocene of Vienna and Bordeaux, the Pliocene of St. Erth, and the Crag. The Crag specimen was found at Sutton.

7. Miliolina circularis (*Bornemann*). Plate V, fig. 4.

Triloculina circularis, *Bornemann*, 1855. Zeitsch. Deutsch. Geol. Gesell., vol. vii, p. 349, pl. xix, fig. 4.

Miliolina circularis, *Brady*, 1884. Report 'Challenger,' p. 169, pl. iv, fig. 3; and pl. v, figs. 13, 14 (?).

— — *Sherborn and Chapman*. Journ. R. Microsc. Soc., ser. 2, vol. vi, pl. xiv, fig. 2.

*Characters.*—This is a near ally of *M. subrotunda*, with a more convex shell and more closely enwrapping chambers.

*Occurrence.*—*Miliolina circularis* appears to be rare in recent seas, and to be confined to comparatively shallow water. The 'Challenger' records are from Prince Edward's Island, Kerguelen Island, and the Bass Strait. As a fossil it is recorded from the London Clay of Piccadilly, Oligocene of Hermsdorf, and quite recently from the older Pliocene of St. Erth (Millett). The figured specimen is from the Coralline Crag of Suffolk,—exact locality unknown.

8. Miliolina bicornis (*Walker and Jacob*); including *M. Brongniartii*. Plate III, figs. 41, 42; and var. Plate IV, fig. 2.

Part I, 1866, page 14; and Appendix II, Table, No. 14.

*Additional Synonyms:*

Frumentaria *fœniculum, Soldani*, 1795. Testaceograph, &c., vol. i, part 3, p. 229, pl. cliv, figs. *bb—gg*.

— *Fœniculum, Soldani*, 1798. Ibid., vol. ii, p. 54, pl. xix, figs. *i*, *k*.

— *phialiformia, Soldani*, 1798. Ibid., pl. xx, figs. *t*, *v*.

Adelosina striata, *d'Orb*, 1826. Ann. Sci. Nat., vol. vii, p. 304, No. 2; Modèles 18 and 97.

Triloculina Brongniartii, *d'Orb.*, 1827. Ann. Sci. Nat., vol. vii, p. 300, No. 23.

— Brongniartiana, *d'Orb.*, 1839. For. Cuba, p. 176, pl. x, figs. 6—8.

Quinqueloculina Brongniartii, *P., J., and B.*, 1865. Ann. Mag. Nat. Hist., ser. 3, vol. xvi, pp. 21 and 34, pl. i, figs. 14, 15.

— — *J., P., and B.*, 1866. Monogr. Foram. Crag, p. 14, No. 7, pl. iii, figs. 41, 42; pl. iv, fig. 2.

— bicornis, *Terquem*, 1875. Plage Dunkerque, p. 39, pl. vi, fig. 6.

Miliolina bicornis and Brongniarti, *Brady*, 1884. Report 'Challenger,' p. 171, pl. vi, figs. 9, 11, 12.

Triloculina Brongniarti, } *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v,
Miliolina bicornis, } p. 220, No. 291 (with synonyms).

Adelosina bicornis (including A. Brongniartii), *Schlumberger*, 1886. Bull. Soc. Zool. France, vol. xi, p. 546—552, with figs. 1—5, 7, and 8 in the text, pl. xvi, figs. 10—15.

Miliolina bicornis, *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 31, 178, 179, 322.

— — *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 113, pl. xxi, figs. 860, 861 *e*.

*Characters.*—At page 14 of Part I *M. bicornis* was referred to as being allied to *M. Brongniartii*; the two forms are now recognised as two stages of the same Foraminifer, indeed M. Schlumberger has shown that in their first stage the shell is an *Adelosina*, and passes on to the three- and five-chambered condition, and that the slight striation visible in the Adelosine stage is retained in *M. bicornis*, and is much augmented in the more complex *M. Brongniartii*. M. Schlumberger groups them under *Adelosina*, as already explained; here it is thought best to use *Miliolina* as the generic name.

*Occurrence.*—*Miliolina bicornis* is a shallow-water form. It occurs in all temperate and tropical latitudes, and is common on the British coasts. Fossil specimens have been obtained from the Eocene of the Paris Basin and the London Clay, from the Miocene of Vienna, and Muddy Creek (Victoria), and from the Pliocene of Italy and St. Erth. In the Crag it has been found at Sutton only.

8*. Miliolina bicornis (*Montagu*), Variety. Plate III, figs. 41, 42 (*Q. Brongniartii*).

Quinqueloculina Boueana, *d'Orb.*, 1846. Foram. Foss. Vien., p. 293, pl. xix, figs. 7—9.
— gregaria, *Andreae*, 1884. Abhandl. geol. Specialkarte von Elsass-Loth., vol. ii, p. 279, pl. xii, figs. 10, 11.
Miliolina Boueana, *Brady*, 1884. Rep. 'Challenger,' p. 173, pl. vii, fig. 13.
— scrobiculata, *Brady*, 1884. Ibid., p. 173, pl. cxiii, fig. 15.
— Boueana, *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 114, pl. xxi, figs. 865, 865 *a*, *b*.

*Characters.*—Short, compact; chambers rounded. As varieties of *Miliolina bicornis* (*Brongniartii*), Dr. Brady (op. cit., page 173) refers to *M. Boueana* (d'Orb.), *M. Nussdorfensis* (d'Orb.), *M. striatella* (Karrer), and *M. costata* (Terquem); and states that his *M. scrobiculata* is probably a variety of the same species.

So also Dr. Goës (op. cit., p. 114) combines these and others in the same varietal group.

*Occurrence.*—The striated adult form of *Miliolina bicornis*, often figured under the name of *M. Brongniartii*, may be taken as the immediate relative of this variety *Boueana;* and, as such, its range is of interest.

Recent specimens of *M. Brongniartii* are of rather common occurrence in the shallower waters of the Mediterranean and of most tropical seas. It has also been found off the coast of Galway. Fossil specimens have been recorded from the Eocene of the Paris Basin, the Miocene of Vienna, of Baljik (Bulgaria), and of Muddy Creek (Victoria); the Tertiary beds of Palermo; and the Pliocene of St. Erth. In the Coralline Crag it has been found at Sutton only.

9. Miliolina pulchella (*d'Orbigny*). Plate IV, fig. 3; Plate VI, fig. 3.

Part I, 1866, page 13; and Appendix II, Table, No. 13.

*Additional Synonyms:*

Adelosina pulchella, *d'Orb.*, 1846. Foram. Foss. Vien., p. 303, pl. xx, figs. 25—30.

QUINQUELOCULINA PULCHELLA, *Terquem* (after *d'Orbigny*), 1878. Mém. Soc. Géol. France, ser. 3, vol. i, No. 3, p. 68, pl. xii, figs. 11—14.

MILIOLINA PULCHELLA, *Brady*, 1884. Report 'Challenger,' p. 174, pl. vi, figs. 13, 14; pl. iii, figs. 10—13 (young forms).

QUINQUELOCULINA PULCHELLA, *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, pp. 219 and 222.

ADELOSINA DUTHIERSI, *Schlumberger*, 1886. Bull. Soc. Zool. France, vol. xi, pp. 553, 554, with fig. 9 in the text, pl. xvi, figs. 16—18.

— PULCHELLA, *Fornasini*, 1894. Foram. Collez. Soldani, Sagg. Oritt., p. 20.

MILIOLINA PULCHELLA, *Goës*, 1894. K. Svensk. Akad. Handl., vol. xxv, No. 9, p. 114, pl. xxi, figs. 862—864.

*Characters.*—A bold, somewhat irregular, costate, quinqueloculine shell; the longitudinal ridges, furrows, and smaller striæ vary in intensity.

Several similar forms have been figured under different names, as shown by the synonyms given in Part I, p. 13, by Brady, loc. cit., and by Dr. Goës, loc. cit.

*Occurrence.*—The habitat of *Miliolina pulchella* is in the comparatively shallow waters of temperate and subtropical seas. It is not commonly recorded in a fossil condition, but it has been obtained in the Miocene of Vienna, the Newer Tertiaries of Italy, and the Upper Pliocene of the Island of Rhodes. In the Crag it has been found, in addition to the specimen recorded from Sutton, from Broom Hill, zones **d** and **e**.

10. MILIOLINA FERUSSACII (*d'Orbigny*), variety. Plate IV, fig. 4.

Part I, 1866, page 12; and Appendix II, Table, No. 12.

*Characters.*—This variety differs from the accepted type of *M. Ferussacii*, especially in being broad instead of narrow, and in having fewer ribs or ridges. The gradations, however, can be seen in *Quinqueloculina Juleana*, *Rodolphina*, and *Mariæ*, d'Orb., 'Foram. Foss. Vienne,' 1846, pp. 298—300, pl. xx, figs. 1—3, 7—9, and 13—15, and particularly *Q. Juleana* as represented by Terquem, 'Anim. Plage Dunkerque,' fasc. 1, 1875, p. 40, pl. vi, figs. 9 *a*—*c*.

*Occurrence.*—The species itself has a wide geographical range, but appears to be confined to comparatively shallow water. Fossil specimens have been obtained from the Gault of Folkestone (Chapman), the Calcaire grossier of the Paris Basin, from the London Clay (Piccadilly), the Miocene of Vienna and of Muddy Creek (Victoria), and the Pliocene of Italy and St. Erth. In the Crag, in addition to

the occurrence already recorded at Sutton, we find it at Sudbourne Hall, Broom Hill, and Gedgrave.

*Sub-family* 2.—Haueininæ.

*Brady's Report 'Challenger,'* 1884, *pp.* 62 *and* 182.

*Characters.*—Chambers partly milioline, partly planospiral or linear.

*Genus* 1.—Sigmoïlina, *Schlumberger*, 1887.

*General Characters.*—Shell spiroloculine or quinqueloculine; chambers at first milioline, afterwards planospiral, with the outer margins of the chambers overlapping on the alternate sides. Transverse section shows two curved sets of chambers making a more or less sigmoidal pattern.

1. Sigmoïlina tenuis (*Czjzek*), 1847. Plate VII, fig. 2.

Quinqueloculina tenuis, *Czjzek*, 1847. Haidingers Naturw. Abhandl., vol. ii, p. 149, pl. xiii, figs. 31—34.
— — *Reuss*, 1849. Denksch. k. Akad. Wien, vol. i, p. 385, pl. l, figs. 8 *a—c*.
Spiroloculina rostrata (?), *Reuss*, 1849. Ibid., p. 382, pl. xlix, fig. 7.
Quinqueloculina tenuis, *Reuss*, 1851. Zeitsch. Deutsch. geol. Gesell, vol. iii, p. 87, pl. vii, fig. 87.
— — *P. and J.*, 1865. Phil. Trans., vol. clv, p. 411, pl. xvii, fig. 84.
Spiroloculina tenuissima, *Reuss*, 1867. Sitzungsb. k. Akad. Wiss. Wien, vol. lv, p. 71, pl. i, fig. 11.
Quinqueloculina, No. 551, *Schlicht*, 1870. Foram. Pietzpuhl, p. 97, pl. xxxvii, figs. 11—13 (=*Spiroloculina tenuis*, Reuss, Sitz. Akad. Wiss., vol. lxii, 1870, p. 456, No. 2).
Spiroloculina (undetermined), *Hantken* (1875), 1881. Mitth. a. d. Jahrb. k. Ungar. geol. Anstalt, vol. iv, p. 20, pl. xiii, fig. 1.
— Berchtoldsdorfensis, *Karrer*, 1877. Geol. K. F.-J. Wasserleitung, p. 375, pl. 16 *a*, fig. 10.
— foliacea, *Schwager*, 1878. Boll. R. Com. Geol. Ital., vol. ix, p. 529, fig. 20.
Quinqueloculina tenuis, *Siddall*, 1878. Proc. Chester Soc. N. Sci., pt. ii, p. 46.
Spiroloculina tenuis, *Brady*, 1884. Rep. 'Challenger,' p. 152, pl. x, figs. 7—11.
Miliolina tenuis, *Balkwill and Wright*, 1885. Tr. R. I. Acad., vol. xxviii (Sci.), p. 324, pl. xii, figs. 3—5.

Spiroloculina panda, var. Rengerriana, *Deecke*, 1886. Mém. Soc. Émul. Montbeliard, ser. 3, vol. xvi, p. 16, pl. i, fig. 28.

Sigmoïlina tenuis, *Schlumberger*, 1887. Bullet. Soc. Zool. Fr., vol. xii, p. 117.

Spiroloculina tenuis, *Burrows, Sherborn, and Bailey*, 1890. Journ. Roy. Microsc. Soc., for 1890, p. 551, pl. viii, figs. 2—4.

— — *De Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, pp. 22, 178, 179, 312.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, p. 222, pl. i, figs. 46, 47.

*Characters.*—Thin, nearly complanate, but somewhat curved or twisted on itself.

*Occurrence.*—*Sigmoïlina tenuis* has a very wide geographical range, and is found in shallow waters and at all depths down to nearly 3000 fathoms. Fossil specimens have been obtained from the Red Chalk of Speeton, the Oligocene of Elsass, the Miocene of the Vienna Basin and of Italy, the Pliocene of Italy and Garrucha, and the Diestian of Antwerp. The Crag specimens were obtained from Sutton, zone **e**, and from Sudbourne.

## *Sub-family* 3.—Peneroplidinæ.

*General Characters.*—Planospiral or cyclical, sometimes crozier-shaped; bilaterally symmetrical.

### *Genus* 1.—Cornuspira, *Schlutze*, 1854.

*Brady's Report 'Challenger,'* 1884, *pp.* 62 *and* 198.

Part I, 1866, page 1; and Appendix II, Table, Nos. 1 & 2.

*General Characters.*—A planospiral undivided tube.

Of the several forms referable to *Cornuspira*, the following may be accepted as recognisable "species," *according to the relative width and involution of the whorls.*

10*a*

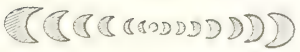
10*b*



Figs. 10*a*, 10*b*.—The outer whorl very wide (typical); inner whorls many and thin. *Cornuspira foliacea* (Philippi), 1844.

11*a*

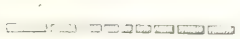
11*b*



FIGS. 11*a*, 11*b*.—The outer whorls thick and rather wide; inner whorls many and thin; the inner margins partly overlap the previous whorls. *Cornuspira involvens*, Reuss, 1849.

12*a*

12*b*



FIGS. 12*a*, 12*b*.—A few rather wide and thick whorls outside (too thin in fig. 12*b*); inner whorls many and thin. *Cornuspira Reussi*, Bornemann, 1855.

13*a*

13*b*

FIGS. 13*a*, 13*b*.—Whorls numerous; the outer whorls slightly wider than the others. *Cornuspira polygyra*, Reuss, 1863.

14*a*

14*b*

FIGS. 14*a*, 14*b*.—Numerous whorls, narrow throughout; but the younger whorls are somewhat thicker, especially the last three or four. *Cornuspira angigyra*, Reuss, 1849.

15*a*

15*b*

FIGS. 15*a*, 15*b*.—Whorls few and uniformly wide and thick throughout. *Cornuspira pachygyra*, Gümbel, 1869.

The last-mentioned form is much like the young *Cornuspira*, whether "*C. involvens*" (megalospheric), figured in Brady's 'Challenger' Report, pl. xi, fig. 3, or the young "*Spirillina foliacea*" (microspheric) in Williamson's 'Recent Foram. Great Britain,' pl. vii, fig. 201. *Cornuspira planorbis*, Schultze, 'Organism. Polythal.,' 1854, p. 40, pl. ii, fig. 21, and *C. foliacea*, Moebius, 'Meeresfauna Mauritius, &c.,' 1880, p. 76, pl. ii, fig. 3, appear to be quite the same as Brady's young "*C. involvens*."

The *Cyclogyra multiplex* of Searles V. Wood, 'Ann. Mag. Nat. Hist.,' vol. ix, 1842, p. 458, pl. v, fig. 5, is very much like the foregoing forms with whorls of uniform width, except in its large size ($\frac{1}{7}$ inch). Mr. S. V. Wood refused to place it in *Cornuspira*, and thought that it was annelidan.

1. Cornuspira foliacea (*Philippi*), 1884. Plate III, figs. 50, 51; woodcuts, figs. 10 *a*, 10 *b*.

Additional synonyms for the list at page 2 of Part I, 1866; see also Appendix II, Table, No. 1.

Operculina ammonitiformis, *Costa*, 1856. Atti Accad. Pontaniana, vol. vii, fasc. 2, p. 209, pl. xvii, figs. 16 *a*, a, b.

Cornuspira [not named], *Wallich*, 1862. North-Atlantic Sea-Bed, pl. v, figs. 12, 12 *a*, and 15.

— — *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 408, pl. xv, fig. 33.

Cornuspiridea, No. 525 (?), & No. 526, *Schlicht*, 1870. Foram. Pietzpuhl, p. 92, pl. xxxv, figs. 9 & 10 (?), 11 & 12.

Spirillina foliacea, *Terquem*, 1876. Plage Dunkerque, fasc. 2, p. 68, pl. vii, fig. 11.

Cornuspira foliacea, *Schwager*, 1877. Boll. R. Com. Geol. Ital., vol. viii, p. 27, fig. 104.

— — *Möbius*, 1880. Beitr. Meeresfauna Insel Mauritius, p. 76, pl. ii, fig. 3.

— — *Goës*, 1882. K. Svenska Vet.-Akad. Handl., vol. xix, No. 4, p. 120, pl. ix, figs. 308—310.

— — *Brady*, 1884. 'Challenger' Report, p. 199, pl. xi, figs. 5—9.

— — *Balkwill and Wright*, 1885. Trans. R. Irish Acad., vol. xxviii (Sci.), p. 326, pl. xii, figs. 1 *a*, *b*.

— — *Fornasini*, 1893. Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. iii, p. 431, pl. i, fig. 4.

— — *Egger*, 1893. Abhandl. k. bayer. Akad. Wiss., Cl. II, vol. xviii, Abth. ii, p. 247, pl. iii, figs. 20, 21.

2. Cornuspira involvens (*Reuss*), 1849 and 1863. Plate III, figs. 52—54; woodcuts figs. 11 *a*, 11 *b*.

Additional synonyms for the list at page 3, Part I, 1866; see also Appendix II, Table, No. 2.

Cornuspira involvens, *Reuss*, 1863. Sitz. k. Akad Wiss. Wien, vol. xlviii, p. 39, pl. i, fig. 2.

— — *Hantken* (1875), 1881. Mitth. a. d. Jahrb. k. Ungar. Geol. Anst., vol. iv, p. 19, pl. ii, fig. 2.

— — *Brady*, 1884. 'Challenger' Report, p. 200, pl. xi, figs. 1—3.

— — *Balkwill and Millett*, 1884. Journ. Micr. Nat. Science, vol. iii, p. 23, pl. i, fig. 1.

— — *Balkwill and Wright*, 1885. Trans. R. Irish Acad., vol. xxviii (Sci.), p. 327, pl. xii, figs. 2 *a*, *b*.

CORNUSPIRA INVOLVENS, *Anon.* [*Chapman*], 1888. Science News, April, p. 389, fig. 7.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, p. 216, pl. xl, figs. 1—3.

Whether the foregoing scheme (p. 126) will hold good when the test of micro- and megalo-spheres (see p. 90) comes to be applied is doubtful. A modification of this scheme, leading to a more natural classification of the *Cornuspiræ*, has been worked out by our collaborateur, Mr. F. W. Millett, with the synonymy in full. It is based upon the form (more or less actual or presumed) of the transverse section of the animal as shown in the woodcut illustrations (figs. 10—15) at pages 126, 127, which were prepared according to Mr. Millett's suggestion. The following lists of the published figures are arranged by Mr. Millett on this plan and in zoological series, instead of in the usual chronological order of dates.

1. Animal much compressed, increasing suddenly in width. Type—*Cornuspira foliacea* (Philippi), 1844; see figs. 10 *a*, 10 *b*.

Cornuspira foliacea, *Williamson*, 1857 (figs. 199, 200).
— — *Jones, Parker and Brady*, 1866.
— — *Balkwill and Wright*, 1885.
— — *Goës*, 1882.
— — *Reuss*, 1865.
— — var. cassis, *Reuss*, 1870 (*Schlicht*, No. 520, 1870).
— — *Brady*, 1884.
— — *Schwager*, 1877.
— — (not named) *Wallich*, 1862.
Operculina ammonitiformis, *Costa*, 1856.
Orbis foliaceus, *Philippi*, 1844.
Operculina plicata, *Czjzek*, 1848.
Cornuspira Reussi (*Bornemann*), *Reuss*, 1870 (*Schlicht*, No. 525, 1870).
— foliacea, *Fornasini*, 1893.
— tenuissima, *Schwager*, 1865.
— — (not named) *Carpenter*, 1885.
— striolata, *Brady*, 1884.

2. Compressed, whorls increasing regularly and uniformly in width. Type —*C. Reussi* (Bornemann, 1855), Reuss, 1866; see figs. 12 *a*, 12 *b*.

Cornuspira carbonaria, *Steinmann*, 1880.
— foliacea, *Chapman*, 1891.
— Reussi, *Bornemann*, 1855.
— involvens, *Burbach*, 1886.
— orbicularis, *Mariani*, 1891.
— cretacea, *Chapman*, 1891.
— — *Reuss*, 1860.
Operculina striata, *Czjzek*, 1848.

3. Transverse section of whorls elliptic (with the long axis in the plane of the spire), passing into round or square. Type—*C. polygyra*, Reuss, 1863; see figs. 13 *a*, 13 *b*.

Spirillina tenuissima, *Gümbel*, 1862.
Cornuspira nummulitica, *Gümbel*, 1868.
Operculina perforata, *Costa*, 1856.
Cornuspira angulata, *Deecke*, 1884.
— pachygyra, *Gümbel*, 1869.
— orbicula (*Terquem*), *Deecke*, 1886.
— Archimedis, *Stache*, 1864.
— numismalis (*Terquem and Berthelin*), *Burbach*, 1886.
— elliptica, *Stache*, 1864.
Spirillina numismalis, *Terquem and Berthelin*, 1875.
Cornuspira filiformis, *Reuss*, 1868.
— polygyra, *Reuss*, 1863.
Spirillina regularis, *Terquem*, 1876.
Cornuspira liasina, *Terquem*, 1866.
— pygmæa, *Andreae*, 1884.
— Ammodiscus, or Spirillina, *Wisniowski*, 1888.
— rugulosa, *Reuss*, 1856.

4. Section of whorls crescentic. Type—*C. involvens*, Reuss, 1850; see figs. 11 *a*, 11 *b*.

Cornuspira involvens, *Reuss*, 1850.
— — — 1863.
— — *Jones, Parker, and Brady*, 1866.
— — *Hantken*, 1875.
Spirillina orbicula, *Terquem*, 1875.
Cornuspira polygyra (*Reuss*), *Hantken*, 1875.
Spirillina foliacea (young), *Williamson*, 1857 (fig. 201).
Cornuspira involvens, *Balkwill and Millett*, 1884.
— — *Brady*, 1884.
— — *Brady, Parker, and Jones*, 1888.
— — *Sherborn and Chapman*, 1889.
— Senonica, *Dunikowski*, 1879.
Frumentaria (quartæ specei), *Soldani*, 1780.
Cornuspira ? cretacea, *Burrows, Sherborn, and Bailey*, 1890 (pl. viii, fig. 6).

5. Thick, depressed; section of whorls oblong or elliptic (with the long axis transverse to the spiral plane). Type—*C. angigyra* (Reuss), 1849; see figs. 14 *a*, 14 *b*.

? Cornuspira polygyra, *Reuss*, 1870; *von Schlicht*, 1870, No. 522.
Operculina angigyra, *Reuss*, 1849.

*Cornuspiræ* with surface-ornamentation.

1. Type—*foliacea*.

CORNUSPIRA STRIOLATA, *Brady*, 1884. 'Challenger' Report, p. 202, pl. cxiii, figs. 18, 19.

In *Operculina plicata*, Czjzek, 1848, 'Haiding. Abhandl.,' vol. ii, p. 146, pl. xiii, figs. 12, 13, the surface-markings seem to be merely lines of *growth*.

2. Type—*Reussi*.

OPERCULINA CARINATA, *Costa*, 1856. Atti Accad. Pontaniana, vol. vii, fasc. 2, pl. xvii, fig. 15.

CORNUSPIRA BORNEMANNI, *Reuss*, 1863. Sitz. k. Akad. Wiss., vol. xlviii, Abth. 1, p. 39, pl. i, fig. 3.

— CARINATA, *Brady*, 1884. 'Challenger' Report, p. 201, pl. xi, fig. 4.

— — *Sherborn and Chapman*, 1889. Journ. R. Micr. Soc. for 1889, p. 484, pl. xi, fig. 6.

— — *Fornasini*, 1893. Mem. R. Accad. Sci. Istit. Bologna, ser. 5, vol. iii, p. 431, pl. i, fig. 5.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, Abth. II, p. 247, pl. iii, figs. 16, 17.

3. Type—*polygyra*.

CORNUSPIRA CRASSISEPTA, *Brady*, 1884. 'Challenger' Report, p. 202, pl. cxiii, fig. 20.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, Abth. II, p. 246, pl. iii, fig. 22.

4. Type—*involvens*.

CORNUSPIRA LACUNOSA, *Brady*, 1884. 'Challenger' Report, p. 202, pl. cxiii, fig. 21.

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In the foot-note at page 1 of Part I of this Monograph Reuss's *Cornuspira cretacea* was referred to *Trochammina* perhaps on insufficient grounds. It appears to comprise two, if not three, forms of *Cornuspira*, thus:

1. 1845–6. 'Verst. Böhm. Kreideform.,' p. 33, pl. xiii, figs. 64 and 65, "*Operculina cretacea*" resembles *C. angigyra*, Reuss.

2. 1860. "Sitzungsb. k. Akad. Wiss. Wien,' vol. xl, p. 177, pl. i, fig. 1, "*C. cretacea*" seems to be a crinkled variety of *C. Reussi.*

3. 1863. Ibid., vol. xlvi, p. 34, pl. i, fig. 10, "*C. cretacea*" is equivalent to *C. Reussi*;[1] fig. 11 and fig. 12, var. "*irregularis*," are most likely *Trochammina* and *Ammodiscus.*

The little discoidal forms, in the Gault of Folkestone, which resemble *Cornuspira* are now found by Mr. Chapman to be *Ammodiscus* if examined by transmitted light.

*Occurrence.—Cornuspira foliacea* has a wide range in recent seas, but is more commonly met with in the North Atlantic. The finest specimens have been found at depths ranging from 300 to 600 fathoms. It occurs, however, in shallow waters, and in the deep sea down to 1500 fathoms. The geological range of this species extends (if the published forms are not *Ammodiscus*) from the Gault of Folkestone (Chapman) through the Calcaire Grossier of the Paris Basin, the Oligocene of Germany (Reuss), the Miocene of Vienna (Czjzek), and of Muddy Creek, Victoria (Howchin), the Pliocene of Southern Italy (Costa) and St. Erth (Millett), to the Pleistocene. The Crag specimens were obtained from Sutton only.

*Cornuspira involvens* is found in all seas, and at depths varying from 7 to 1900 fathoms. It is, however, found but rarely in depths exceeding 700 fathoms. It is specially at home in the north and south temperate and frigid zones. Its geological range equals that of *C. foliacea*, but it has also been recorded from the London Clay (Sherborn and Chapman). In the Crag, in addition to the occurrence already recorded from Sutton, we have found it at Broom Hill and Gedgrave.

### *Genus* 2.—Peneroplis, *de Montfort*, 1808.

*Brady, Report 'Challenger,' pp.* 62 *and* 203—208.

Part I, 1866, page 17.

*General Characters.*—Chambers undivided; either plano-spiral throughout, or at first spiral, then rectilinear or cyclical.

[1] And referred by Reuss to the corrugated form, ibid., vol. xl, p. 177, pl. i, fig. 1.

1. Peneroplis planatus (*Fichtel and Moll*). Plate VI, fig. 5.

Part I, 1866, page 19.

*Characters.*—Of the broad, complanate forms of *Peneroplis*, only one specimen has been met with in the Crag. It is an outspread variety of *P. pertusus*. This individual shows irregularly periodical restrictions in its growth, owing to unfavorable circumstances in its surroundings; but otherwise it is a good representative of *Pl. planatus*. See Brady, Report 'Challenger,' pages 204 and 206, pl. xiii, fig. 15; fig. 5, pl. vi, is equivalent to Carpenter's fig. 1, pl. ii, 'Philos. Trans.,' vol. cxlix, 1859.

*Occurrence.*—See page 134.

2. Peneroplis (Dendritina) arbuscula (*d'Orbigny*). Plate III, figs. 48, 49.

Part I, 1866, pages 17 and 19; and Appendix II, Table, No. 17.

*Characters.*—This is one of the medium-sized nautiloid forms of *Peneroplis pertusus* (Forskål), having a dendroid or ramifying orifice. See Brady, Report 'Challenger,' 1884, p. 204. Pl. III, figs. 48, 49, are equivalent to Carpenter's figs. 12 and 16, pl. ii, 'Philos. Trans.,' vol. cxlix, 1859; and, for the aperture, to the woodcuts of *Dendritina*, figs. *a* and *c* at p. 9, and figs. *a*—*d* at p. 11 of the same memoir.

*Occurrence.*—See page 134.

3. Peneroplis cylindraceus (*Lamarck*). Plate VII, fig. 3.

Part I, 1866 (*Spirolina*), pages 18 and 19; and Appendix II, Table, No. 18.

*Characters.*—This modification of *Peneroplis* has been known as *Spirolina cylindracea*, and was so described in Part I of this Monograph. Synonyms and some figures are given by Brady, Report 'Challenger,' 1884, p. 205, pl. xiii, figs. 20, 21.

The figure of *P. cylindraceus*, Pl. VII, fig. 3 (lost specimen from the Crag),[1] is from a sketch by the late Dr. H. B. Brady.

[1] See Part I, page 11, foot-note.

*Occurrence.*—*Peneroplis planatus*, *P. arbuscula*, *P. cylindraceus*. The genus *Peneroplis* has been subdivided in the 'Challenger' Report into seven well-marked groups, having as their types *P. planatus*, *P. pertusus*, *P. arietinus*, *P. cylindraceus*, *P. lituus*, *P. carinatus*, and *P. lævigatus*. Where the genus abounds, specimens of each of these types are to be met with, together with intermediate forms linking the types. This fact is remarkably illustrated by the forms found in the Coralline Crag. Of the three specimens discovered, one is referrible to each of the types *planatus*, *arbuscula*, and *cylindraceus*.

The genus *Peneroplis* is commonly found in the shallow waters of tropical and subtropical seas; but occasional specimens have been taken from depths as great as 435 fathoms. The occurrence of *Peneroplis* as a fossil is somewhat rare. *P. arbuscula* is recorded from the Aquitanian near Bordeaux, and the Miocene of Vienna. *P. planatus* (by d'Orbigny, 'Ann. Sci. Nat.,' vol. vii, 1826, p. 285, No. 1) from the Mediterranean, New Holland, and the island of Rawack; the so-called *Peneroplis* [*?*] *prisca* (by Reuss, 'Denkschr. k. Ak. Wiss. Wien,' vol. xxiii, 1864, p. 9) from the Nummulitic Formation of Styria; and *P. cylindraceus* from the Miocene of Vienna. The Crag specimens were derived as follows:—*P. planatus* from zone **d**, Broom Hill; *P. arbuscula* from Sudbourne or Gedgrave; and *P. cylindraceus* from Sudbourne.

## *Genus* 3.—Orbiculina, *Lamarck*, 1816.

*Brady, Report 'Challenger,' pp.* 62 *and* 208.

Part I, 1866, p. 20.

*General Characters.*—Chambers subdivided by transverse secondary septa; early segments embracing. Planospiral throughout, or partly cyclical; contour nautiloid, crosier-shaped, orbicular, or complanate.

### 1. Orbiculina adunca (*Fichtel* and *Moll*). Plate III, figs. 43 and 44; Plate VII, fig. 4.

Part I, 1866, pp. 20 (*O. adunca*) and 21 (*O. compressa*); and
Appendix II, Table, Nos. 19, 20.

*Characters.*—Fig. 43 is an adult individual in which the initial spiral portion of the shell is quite obscured, having been completely and symmetrically surrounded

by successive concentric *annuli* of chambers. D'Orbigny's fig. 4 (*O. compressa*), pl. viii, 'Foram. Cuba,' illustrates an analogous discoidal specimen; and his fig. 5 is one which retains evidence of the central spire, just as is also seen in Brady's fig. 9, pl. xiv, Report 'Challenger.' Fig. 43 is equivalent to Carpenter's fig. 11, pl. xxviii, 'Phil. Trans.,' vol. cxlvi, 1856. Fig. 44 is an approximately adult individual of this variable form, which changes much as to details in closing up its subdiscoidal shell by the meeting and coalescence of the newest marginal chambers. This specimen stands close to such forms as are represented by figs. 7 and 8 in pl. xiv, Report 'Challenger,' and described by Brady at p. 209; and is equivalent to Carpenter's fig. 4, pl. xxviii, 'Philos. Trans.,' vol. cxlvi, 1856. Fig. 44 is the specimen P. 3094 in the British Museum. Pl. vii, fig. 4, is a broken specimen from Sutton, which evidently had much more of the spire exposed than the specimen illustrated by pl. iii, fig. 44, and in this respect it has a relationship with *Peneroplis (?) prisca*, Reuss ('Denksch. k. Akad. Wien,' vol. xxiii, 1864, p. 9, pl. i, fig. 7), from the Eocene of Styria. The shape of the chamberlets, which are worn open in our fig. 44 and fig. 4, is like that of *Orbitolites tenuissimus*, Carpenter; but this is evidently a modification of the shorter chamberlets in fig. 43, and need not be mistaken for the externally striate structure of *Peneroplis*.[1]

*Occurrence.*—*Orbiculina aduncа* is essentially a tropical form. It frequents shallow waters, and the greatest depth at which it has been found is 450 fathoms. As a fossil it is rare, and has been recorded with certainty only from the Miocene of Vienna. In the Coralline Crag the true *aduncа* has been found at Sutton, zone **e**. The specimens of the complanate variety, Pl. III, fig. 43, were also obtained from Sutton.

[1] Commenting on the absence of rigidity in adherence to a type-form, which has been noticed in the genera and species of the Foraminifera by many observers, Dr. A. Goës remarks (in a letter), "If we take, for instance, *Peneroplis* and *Orbitolites* we see a constant oscillation going on between the two forms *per medium* of *Orbiculina*,—*Orbitolites* breeding its own form, also *Orbiculina*, and perhaps also *Peneroplis*." In the progress (with atavism) to a higher type, the primal form becomes "a larval stage to the latter until it becomes reduced to a single embryonal chamber, and the new type is ready. The same with *Miliolina*, *Globigerina*, *Uvigerina*, *Cristellaria*, *Frondicularia*, *Textilaria*, &c. This oscillation is best seen in *Orbiculina*, because there the primal type and the final type are included in the same shell. We thus see that many of our 'genera' and 'species' are not founded on natural principles."

*Genus* 4.—Orbitolites, *Lamarck*, 1801.

*Brady*, *Report 'Challenger,' pp.* 62 *and* 210.

Part I, 1866, page 22.

*General Characters.*—Discoid; commencement either spiral and non-embracing or with one or more inflated chambers, then cyclical; chambers divided into chamberlets.

1. Orbitolites complanatus, *Lamarck*. Plate III, figs. 45—47 (*O. orbiculus*).

Part I, 1866 (*O. orbiculus*), page 23; and Appendix II, Table, No. 21.

*Additional Synonyms:*

Orbitolites complanatus, &c., *Carpenter*, 1883. Report 'Challenger,' xxi, pp. 1—49, pl. i—viii; Philos. Trans., 1883, p. 562, figs. 4 & 5; Journ. Quekett Microsc. Club, ser. 2, vol. ii, 1885, p. 91, &c. (figs.).

— — *Brady*, 1884. Report 'Challenger,' Zool., vol. ix, p. 218, pl. xvi, figs. 1—6; pl. xvii, figs. 1—6.

*Characters.*—In Part I this Foraminifer was treated under the name of *Orbitolites orbiculus*, derived from the "*Nautilus orbiculus*" described by Forskål as a white orbicular organism, flat on both sides (faces), marked with subconcentric bead-like, spiral lines, and having all the outer margin perforated with double pores. In his Report 'Challenger' (1884) Brady has ignored this name, without any explanation. Perhaps he preferred the alternative offered by Parker and Jones in the 'Annals Mag. Nat. Hist.,' ser. 3, vol. viii, 1861, p. 235, and thus regarded it as an adult *Orbiculina adunca* (like fig. 43, Pl. III, see above, page 134); and perhaps in his opinion Forskål's allusion to its likeness to "*Nummulites placentula*," probably his "*N. major*" (now known as *N. complanatus*), may have made the proposed synonymy less likely. Carpenter also missed this name; and with others he made Lamarck's name, "*O. complanatus*," so common that we are inclined to allow the doubtfulness of Forskal's specimen, and to let his be merged in Lamarck's better known name.

*Occurrence.*—*Orbitolites complanatus* is at home in the shallow waters of tropical and subtropical seas, particularly among the coral reefs of the North and South Pacific and the Indian Ocean. Fossil specimens of this species are particularly abundant and very finely developed in the Calcaire Grossier of the Paris Basin. Specimens are also recorded from the Eocene of Belgium and the Bracklesham Beds; and from the Miocene of Malta (Brady), and of Muddy Creek, Victoria. The Crag examples were obtained from Sutton, and probably were derived from some older Tertiary beds.

*Sub-family* 4.—ALVEOLININÆ.

Spiral, elongate in the axis of convolution; chambers subdivided.

*Genus* 1.—ALVEOLINA, *d'Orbigny*, 1826.

*Brady, Report 'Challenger,'* 1884, *pp.* 62 *and* 221.

*General Characters.*—Subglobular, elliptic, or fusiform. Recent forms often with subdivided chamberlets.

1. ALVEOLINA, sp. Woodcut, fig. 10.

Part I, 1866, page 24; and Appendix II, Table, No. 22.

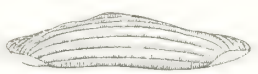

FIG. 16.—*Alveolina Boscii* (Defrance) × 7½. After Brady, Report 'Challenger,' pl. xvii, fig. 9.

One or two lost specimens, which had been collected at Sudbourne by Mr. S. V. Wood, but much worn and indeterminate, were mentioned at page 24. They were probably derivatives from some older Tertiary formation.

*Occurrence.*—*Alveolina Boscii* is a shallow-water form, and is confined to warm latitudes. It is of common occurrence among coral reefs at depths of twenty or thirty fathoms. This species is a very common fossil in the Eocene of the Paris Basin, and in the Bracklesham Beds of Sussex. The Crag specimens were, in all probability, derived from an older formation.

## II. ARENACEA.

*General Characters.*—Shells made of sand-grains and other materials, agglutinated together by ferruginous, calcareous, chitinous, or siliceous cement; some, such as *Textilaria* and *Bulimina*, are hyaline, and others porcellaneous or chitinous, in an early stage. Many are sandy isomorphs of porcellaneous and hyaline types.

### *Family* 1.—LITUOLIDÆ.

*General Characters.*—Of the *Lituolidæ* there are few representatives among the Foraminifera collected from the Crag. In this family the test is arenaceous, usually regular in contour. The septation of the polythalamous forms is often imperfect; chambers often labyrinthic.

#### *Sub-family* 1.—LITUOLINÆ.

*General Characters.*—Test made of coarse sand-grains; rough externally, often labyrinthic internally.

##### *Genus* 1.—HAPLOPHRAGMIUM, *Reuss*, 1860.

*Brady, Report 'Challenger,' pp.* 65 *and* 300.

*General Characters.*—Test free; made of coarse sand-grains; partly or entirely spiral; nautiloid or crozier-shaped; chambers simple.

1. HAPLOPHRAGMIUM GLOMERATUM (*Brady*). Plate V, fig. 12.

LITUOLA GLOMERATA, *Brady*, 1878. Ann. Mag. N. H., ser. 5, vol. i, p. 433, pl. xx, fig. 1.
HAPLOPHRAGMIUM GLOMERATUM, *Wright*, 1881. Proc. Belfast Nat. H. Club, Append., pl. viii, fig. 1.
— — *Brady*, 1882. Denks. k. Akad. Wien, vol. xliii, p. 100.

HAPLOPHRAGMIUM GLOMERATUM, *Brady*, 1884. Rep. 'Challenger,' p. 309, pl. xxxiv, figs. 15—18.

— — *Balkwill and Millett*, 1884. Journ. Micr. Nat. Sci., vol. iii, p. 25, pl. i, fig. 6.

— — *Chapman*, 1892. Journ. R. Micr. Soc., p. 321, pl. v, fig. 8.

— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 23, pl. v, figs. 134—139.

*Characters.*—Spiral, subglobular; segments few, three or four in the outer whorl.

*Occurrence.*—This species has a wide geographical range. It is common in Arctic and Antarctic seas at moderate depths (14 to 200 fathoms). In tropical and subtropical seas it is found at greater depths. As a fossil it was first recorded by Mr. Chapman from the Gault of Folkestone, where it is rather common. We have found the form that is here figured in nearly every zone of the Crag examined. It is common at Sudbourne Hall, zone **d**, and at Aldborough, zone **g**.

NOTE.—There is much doubt as to this being *Haplophragmium glomeratum*. It may well be the young (initial) form of *Textilaria gibbosa*. This supposition is borne out by the fact that wherever *T. gibbosa* is common, the small form here referred to *H. glomeratum* is also plentiful. Arenaceous species, besides *Textilaria*, are, as a rule, very rare in the Crag.

### *Sub-family* 2.—TROCHAMMININÆ.

*Brady, Report 'Challenger,'* 1884, *pp.* 66 *and* 321.

*General Characters.*—Test thin, consisting of minute sand-grains incorporated with calcareous or other inorganic cement, or embedded in a chitinous membrane; exterior smooth, often polished; interior smooth, often reticulate, not labyrinthic.

*Trochammina*, Jones and Parker, 1859 (see Part I, 1886, pp. 25—27).—More or less septate; rotaliform, trochoid, or irregular.

*Ammodiscus*, Reuss, 1861 (divided off from the foregoing).—Non-septate and tubular; spiral or irregular.

### *Genus* 1.—WEBBINA, *d'Orbigny*, 1839.

*Brady, Report 'Challenger,' pp.* 66 *and* 348.

*General Characters.*—Adherent; single tent-like chamber, or a series, connected by semi-tubular stoloniferous passages.

1. Webbina hemisphærica, *Jones, Parker, and Brady.* Plate IV, fig. 5.

Part I, 1866, p. 27; Appendix II, Table, No. 23.

| | | | |
|---|---|---|---|
| Webbina hemisphærica, *J., P., and B.*, | | 1866. | Monogr. Foram. Crag, p. 27, pl. iv, fig. 5. |
| — | — | *Brady*, 1884. | Report 'Challenger,' p. 350, pl. xli, fig. 11. |
| — | — | *Egger*, 1893. | Abhandl. k. Bayer. Akad. Wiss., vol. xviii, Abth. 2, p. 226, pl. xiv, figs. 1—3. |

This form, represented in 1866 by one specimen from the Crag of Sutton, was regarded as variety *hemisphærica* of *Webbina irregularis*, d'Orb., which Parker and Jones looked upon as belonging to a sub-type of their *Trochammina*, which also comprised some forms since referred to *Ammodiscus*.

*Occurrence.*—*Webbina hemisphærica*, first described in the First Part of this Monograph, has since then been found in the living state in shallow water (twenty-five to thirty-three fathoms) at two points off the coast of Durham, by G. S. Brady and D. Robertson ('Report Brit. Assoc.' for 1875, pp. 188, 189); and by the 'Gazelle' at 69 metres off the Cape-Verd Islands. The Crag specimen was obtained from Sutton.

It may be mentioned that the specimens which have been recorded as *Webbina* from the Lias probably belong to *Nubecularia*.

Note.—In Part I (1866) the *Lagenidæ* followed here, but it is now more convenient to take in order others of the arenaceous group, so called, although they are hyaline when young.

## *Family* 2.—TEXTILARIIDÆ.[1]

*Brady, Report 'Challenger,'* 1884, *pp.* 67 *and* 354.

*General Characters.*—Tests of the larger forms arenaceous, either with or without a perforate calcareous basis; small forms hyaline and perforate. Chambers arranged in two or more alternating series, or spiral, or confused; often dimorphous, comprising the *Textilariinæ* and *Bulimininæ*.

[1] The genera *Textilaria*, *Bulimina*, and *Cassidulina* were placed in the midst of the Hyaline Foraminifera in Part I of this Monograph,—see the tables in the Appendices I and II. As their shell is "perforate," and as its sandy condition is not present in all the forms, and therefore is not an essential feature, *Textilaria* and *Bulimina* are in this respect intermediate to the Arenaceous and Hyaline groups, and (with their Hyaline sub-genera) may be placed last in order among the former, or first among the latter, thus coming between the *Lituolidæ* and the *Lagenidæ*.

*Sub-family* 1.—Textilariinæ.

*General Characters.*—Typically bi- or tri-serial; often bi-, sometimes trimorphous.

*Genus* 1.—Textilaria, Defrance (*Textularia*), 1824.

*Brady, Report 'Challenger,'* 1884, *p.* 356.

*Synonyms of* Textilaria :[1]

Polymorphum, *Soldani.*
Nautilus, *Soldani, Batsch.*
Grammostomum, in part. } *Ehrenberg.* (For notices of various forms figured by Ehrenberg, that probably come under *Textilaria sagittula*, d'Orb., see the 'Annals and Mag. Nat. Hist.,' ser. 4, vol. x, 1872, pp. 284, 286, 287, 288, 290, and 456.)
Clidostomum ?
Guttulina, in part.
Proroporus, in part.
Polymorphina, in part.
Heterostomum.
Rhynchoplecta ?
Rhynchopleura ?
Cribrostomum, in part, *Möller.*
See also the foot-note.

*General Characters.*—Shell free, regular, and equilateral; conical, pyramidal, pyriform, cuneiform, or oblong. Segments numerous, arranged in two alternate parallel series. Septal orifice at the centre of the umbilical margin of the segment close to its line of contact with the preceding and opposite segment.

[1] The name *Textilaria*, used by Ehrenberg, 1839, is here adopted in accordance with the recommendation in the 'Rules for Zoological Nomenclature (No. 14), Brit. Assoc.,' that Latin orthography should be adhered to. From Mr. C. D. Sherborn's printed and manuscript bibliographies of Foraminifera we are able to state that more than twenty-five authors have adopted *Textilaria*, and upwards of eighty-five have used "*Textularia*," as shown in the following list:

1. Textilaria.—Ehrenberg, Bronn, von Reuss, Phillips, Schultze, Terquem, Stache, Karrer, von Hantken, von Gümbel, Schwager, Kübler, Zwingli, Berthelin, von Schlicht, de Folin, Moebius, Schlumberger, Uhlig, Andreæ, Hoernes, Deecke, Neumayr, Beissel, Holzapfel, and others.

2. Textularia.—Defrance, d'Orbigny, Nilsson, Roemer, Michelotti, von Hagenow, Macgillivray, Bailey, Williamson, Cornuel, Czjzek, Alth, Costa, Egger, Jones, Parker, Brady, Carpenter, Pictet, Seguenza, Alcock, Sars, Fischer, Pourtales, Greene, G. M. Dawson, J. W. Dawson, Norman, Siddall, Vine, Bütschli, Terrigi, Goës, Fornasini, Woodward and Thomas, Wright, Balkwill, Millett, Sherborn, Chapman, Malagoli, Burrows, A. Agassiz, Dervieux, Guppy, de Amicis, and others.

The *Textilariæ* are so very variable in their growth, forming vesicular, quadrate, or flattened chambers, and arranging them sometimes quite regularly and at other times with a want of neatness, that there may be almost as many names for them as there are groups of more or less similar individuals.

Specimens having sandy shell-tissue were grouped as *Plecanium* by von Reuss ('Sitzungsb. k. Akad. Wiss. Wien,' vol. xliv, 1861, p. 383).

1. Textilaria sagittula, *Defrance*, 1824. Plate III, figs. 7—9; Plate V, figs. 15, 16, 18.

Part I, 1866, Appendix II, Table, No. 64.

Polymorpha sagittulæ, *Soldani*, 1791. Testac., vol. i, part 2, p. 120, pl. cxxxiii.

The figures given by Soldani are rough and obscure, but figs. O, P, Q, R, T, V, may be equivalent to various forms of *T. sagittula*. Fig. S appears to be *T. jugosa*, Brady.

Textularia sagittula, *Defrance*, 1824. Dict. Sci. Nat., vol. xxxii, p. 177; vol. liii, p. 344; Atlas Conch., pl. xiii, fig. 5.
— — *Blainville*, 1825. Malacologie, p. 370, pl. v, fig. 5.
— — *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 263, No. 20.
— Saulcyana, *Idem*, 1839. Foram. Cuba, p. 142, pl. i, figs. 21, 22.
— cuneiformis, *Idem*, 1839. Ibid., p. 138, pl. i, figs. 37, 38.
— Baudouinana, *d'Orb.*, 1840. Mém. Soc. Géol. France, vol. iv, Mém. No. 1, p, 46, pl. iv, figs. 29, 30.
— sagittula, *Reuss*, 1846. In Geinitz's Grundriss, &c., part 2, p. 680, pl. xxiv, fig. 72.
— Nussdorfensis, *Idem*, 1846. Foram. Foss. Vienne, p. 243, pl. xiv, figs. 17—19.
— Bronniana, *Idem*, 1846. Ibid., p. 244, pl. xiv, figs. 20—22.
— deperdita, *Idem*, 1846. Ibid., figs. 23—25.
— pala, *Czjzek*, 1848. Haidingers Nat. Abhandl., vol. ii, p. 148, pl. xiii, figs. 25—27.
— prælonga, *Idem*, 1848. Ibid., p. 149, pl. xiii, figs. 28—30.
— acuta, *Reuss*, 1850. Denksch. k. Akad. Wien, vol. i, p. 381, pl. xlix, fig. 1; 1855, in Quenstedt's Handb. Petref., edit. 3 (5), p. 1059, pl. lxxxvi, fig. 60.
— sp., *Mantell*, 1850. Q. J. G. S., vol. vi, p. 330, pl. xxix, fig. 1.
— mutata, *Costa*, 1856. Atti Accad. Pontan., vol. vii, fasc. 2, pl. xxiii, fig. 19, and indet., fig. 20.
— cuneiformis, *Williamson*, 1858. Rec. Foram. Brit., p. 75, pl. vi, figs. 158, 159.
— sagittula, *P. and J.*, 1863. Ann. Mag. N. H., ser. 3, vol. xi, p. 96.

Textularia agglutinans, var. sagittula, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 369, pl. xvii, figs. 77 *a*, *b*.

— sagittula, *J., P., and B.*, 1866. Monogr. Foram. Crag, Append. II, Table, No. 64.

Plecanium lythostrotum, *Schwager*, 1866. Novara-Exped. Geol. Theil, vol. ii, p. 194, pl. iv, figs. 4 *a—c*.

— solitum, *Idem*, 1866. Ibid., p. 195, pl. iv, figs. 6 *a—c*.

Textilaria alpina, *Kübler and Zwingli*, 1866. Neujahrsblatt Winterthur, p. 19, pl. iii, figs. 11 and 19.

Textularia sagittula, *Brady and Robertson*, 1870. A. M. N. H., ser. 4, vol. vi, pp. 299, 306.

— — *P., J., and B.*, 1871. Ann. Mag. N. H., ser. 4, vol. viii, p. 168, pl. xi, fig. 114.

— — *Brady and Robertson*, 1875. Report Brit. Assoc, p. 190.

Textilaria cuneiformis *Terquem*, 1881. Foram. Dunkerque, fasc. iii, p. 129, pl. xvii, figs. 2 *a*, *b*.

— deperdita, *Schlumberger*, 1882. Feuil. Jeun. Nat., pl. ii, fig. 1.

Textularia sagittula, *Goës*, 1882. K. Svensk. Vet.-Akad. Handl., vol. xix, p. 72, pl. v, figs. 133—136 [var.], 144—146, 147—149 [var.], 150 and 151 [var.].

— — *Brady*, 1884. Report 'Challenger,' p. 361, pl. xlii, figs. 17, 18.

— — *Balkwill and Wright*, 1885. Trans. R. Irish Acad., vol. xxviii (Sci.), p. 332, pl. xiii, figs. 15—17 (fig. 15 partly = *pectinata*, Reuss).

— — (after *Soldani*), *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, pp. 116 and 277—279.

— — *Fornasini*, 1887. Ibid., vol. vi, pp. 394, 395.

— — *Idem*, 1888. Ibid., vol. vii, p. 46, pl. iii, figs. 2—4.

— — *Malagoli*, 1887. Ibid., vol. vi, p. 520, pl. xiii, fig. 1.

— — *B., P., and J.*, 1888. Trans. Zool. Soc., vol. xii, part 7, No. 1, p. 219, pl. xlii, figs. 1 *a*, *b*.

— — *Agassiz*, 1888. Cruises of the 'Blake,' vol. ii, p. 164, fig. 500.

— — *Haeusler*, 1890. Abhandl. Schweiz. Pal. Ges., vol. xvii, p. 70, pl. xi, figs. 20—25, and 38.

— — *Chapman*, 1892. Journ. Microsc. Soc. for 1892, p. 328, fig. 16, roundish edges.

— — *Egger*, 1893. Abhandl. Akad. Bayer., vol. xxviii, part 2, pp. 268 and 271, pl. vi, figs. 8—10 (chambers more gibbose than usual).

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 41, 180, 181.

— — *Idem*, 1893. Ibid., vol. xii, p. 331.

— cf. conica, *d'Orb.*, *Idem*. Ibid., p. 339, pl. iii, fig. 6.

TEXTULARIA SAGITTULA, var. CUNEIFORMIS, *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 36, pl. vii, figs. 288—290.

— WILLIAMSONI, *Goës*, 1894. Ibid., p. 36, pl. vii, figs. 285—287.

*Characters.*—Shell compressed, cuneiform, thickest along the centre. Margins thin, sometimes carinate. Segments numerous, narrow, more or less horizontal; usually those near the top, but sometimes those nearest the middle, are the longest. Sutures slightly constricted. Texture sub-arenaceous.

The spathulate, narrow-chambered, thin-edged *Textilariæ*, which find their best representative form in *T. sagittula*, Defrance, constitute the commonest and most widely distributed section of the genus. They seldom attain the dimensions of average specimens of *T. gibbosa* or *T. agglutinans*, nor do they usually present so rough an exterior; but, on the other hand, they are larger and more stoutly built than such forms as *T. pygmæa* or *T. variabilis*.

The contour of the shell is very well described by Prof. Williamson, under the head *Textularia cuneiformis, typica*, who notes the rapid increase in the size of the earlier segments, which imparts to young specimens their triangular form, and the subsequent regularity and evenness in length of the chambers, frequently decreasing rather than increasing in dimensions from the middle of the shell. Sometimes, as in the specimen figured by d'Orbigny from the Canaries, the sutures are limbate.

Pl. III, figs. 7—9, are ordinary forms with straight chambers and sharp edges. Pl. V, fig. 15, has widened out more rapidly than usual, and the terminal chamber has grown out of place, with a tendency to linear growth. Fig. 16 has its chambers less symmetrically arranged than in the type-form. Fig. 18 is symmetrical and longer than usual, but slightly flexed, as in many other instances. Fig. 19 will be referred to as var. *jugosa* (Brady). Fig. 20 is a short, strong, broad variety (*sulcata*), in which the inner part of each chamber protrudes outward, either close to the median junction (as on one side), or a little way from it (on the other), leaving a depressed channel along the middle of the shell. As it is the upper edge of the chamber (on one side) that thickens to produce this feature, this variety is related to that shown by fig. 19. Fig. 21 is a small specimen, either young or a dwarf form, probably the latter, and is referred to further on (*Flabelliformis*).

It may be remarked that *Text. Jonesi*, Brady, 'Monogr. Carb. Perm. Foram., Pal. Soc.,' 1876, p. 133, pl. x, figs. 20—22, are broad, flat, palæozoic forms of *T. sagittula*; and that *T. anceps*, Reuss, 'Böhm. Kreid.,' 1845, vol. i, p. 39, pl. viii, fig. 78, and pl. xiii, fig. 78; and 'Sitz. Ak. Wien,' vol. xl, 1860, p. 234, pl. xiii, fig. 2, is very near to the same species, although its chambers are not horizontal, but somewhat inclined (still more sloping in *T. aciculata* and *pygmæa*). In Terrigi's figs. 24—27,

pl. ii, 'Atti Accad. Pontif. Lincei,' vol. xxxiii, 1880, p. 69, passages from *T. aciculata* towards *sagittula* are well shown.

*T. obsoleta*, Reuss, 'Böhm. Kreid.,' l. c., fig. 79, is a rather thick form of *sagittula*. *T. Partschii* as there figured only differs by its rounded edges; figured elsewhere by Czjzek (1848, 'Haiding. Abh.,' vol. ii, pl. xiii, figs. 28—30), it is equivalent to *gibbosa* with horizontal chambers; and *prælonga*, ibid., is a long narrow *sagittula*.

*Plecanium lanceolatum*, Karrer, 'Sitz. Akad. Wien,' vol. lvii, 1868, p. 129, pl. i, fig. 2, is an elongate *sagittula*, which loses its sharp edges in the upper part, where the chambers become rather thick and squarish, as in Reuss's figure of *T. Partschii*.

So also *Text. luculenta*, Brady, var. *Calaritana*, Fornasini ('Boll. Soc. Geol. Ital.,' vol. vi, 1887, p. 389, pl. x, figs. 3—3 *b*), begins as *sagittula*, and grows up with thicker, more inclined, and less regular chambers. The variety has sharp edges and more inclined chambers, set more loosely together than Brady's figs. 5—8, pl. xliii, p. 364, Report 'Challenger.'

*T. Baudouinana*, d'Orb., from the Chalk ('Geologist,' 1863, p. 294, pl. xv, fig. 6), is symmetrical in outline and in the setting-on of its depressed or narrow chambers; it can scarcely, if at all, be distinguished from a well-grown *T. sagittula*. D'Orbigny states that it is near to *T. communis*, d'Orb, 'Ann. Sci. Nat.,' vol. vii, 1826, p. 263, No. 27.

*Occurrence.*—*Textilaria sagittula* is of very common occurrence in the shallow waters of temperate seas, and has a very wide geographical range. Specimens have been found at depths of 2675 fathoms in the North Atlantic, and at 1425 fathoms in the South Atlantic. Geologically also *T. sagittula* is of very frequent occurrence. The records at present appear to be from the Neocomian (Bargate Beds) of Surrey (Chapman); the Gault of Folkestone (Chapman); throughout the Chalk; Eocene (London Clay); Miocene of Vienna, of Muddy Creek, and elsewhere; Pliocene of Italy, Garrucha, and St. Erth; and from several Post-Tertiary deposits. In the Coralline Crag we have found it, with varying frequency, in every zone examined, and it is the only species of *Textilaria* recorded from the Red Crag.

1*. Textilaria sagittula, *Defrance*, var. jugosa (*Brady*). Plate V, fig. 19.

Polymorpha sagittulæ, *Soldani*, 1791. Testac., &c., vol. i, part 2, p. 120, pl. cxxxiii, fig. *s*.

Textularia sagittula, *d'Orb.*, 1839. Foram. Canaries, p. 138, pl. i, figs. 19—21.

— — *Reeve*, 1842. Conch. Syst., vol. ii, p. 292, pl. ccvii, fig. 10.

Textularia sagittula, *Costa*, 1856. Atti Accad. Ponton., vol. vii, p. 291, pl. xxiii, fig. 11.
— jugosa, *Brady*, 1884. Report 'Challenger,' p. 258, pl. xlii, figs. 7 *a*, *b*.
— sagittula, *Fornasini*, 1887. Boll. Soc. Geol. Ital., vol. vi, p. 374, pl. ix, figs. 1, 2.
— — *Idem*, 1888. Ibid., vol. vii, p. 46, pl. iii, figs. 2—4.
— jugosa, *Egger*, 1893. Abhandl. k. Ak. Bayer., vol. xxviii, part 2, p. 273, pl. vi, figs. 19—21 (of rather irregular growth).

This variety of *T. sagittula* has the sutures limbate, either being thickened and swollen with an exogenous deposit of shell-substance, or overlapped by the extra shell-substance at the top edge of each chamber. Another limbate variety is the *T. flabelliformis*, Gümbel, noticed at page 147; and Fornasini's "forma abbreviata" of *T. sagittula*, 'Boll. Soc. Geol. Ital.,' vol. vi, 1887, p. 400, pl. i, fig. 2.

*Occurrence.*—*Textilaria sagittula*, var. *jugosa*, has been found in the living state in considerable numbers in the shore sand on the east coast of Madagascar. Specimens were also found, but of diminutive size, by the 'Challenger' off Raine Island, Torres Strait, at a depth of 155 fathoms; and by the 'Gazelle' off the north-west coast of Australia. The Gulf of Suez (15 to 20 fathoms) is another locality whence specimens have been obtained. The Crag specimen is in Mr. F. Chapman's Collection, and was probably from Sutton; this is the first record of the variety in a fossil condition.

2. Textilaria sulcata, sp. nov. Plate V, fig. 20.

*Characters.*—Shell short, triangular in outline, compressed, chambers horizontal, with sharp lateral edges. A broad furrow with unequal sides marks the median line where the chambers meet. This is due to a partial thickening, or limbation, of the inner angle of the upper margin of the chambers (after the early growth of the shell) on one side, and by a succession of protuberances on the chambers of the other side.

The local thickening of the margins of the chambers near the median line of junction is evidently analogous to, if not identical with, that in fig. 19, although not of equal intensity.

*Occurrence.*—The Crag specimen of *Textilaria sulcata*, figured Pl. V, fig. 20, is in the Searles-Wood Collection in the British Museum, and was probably obtained from Sutton. We have this species from the Miocene of Muddy Creek, Victoria, although it is not recorded nor figured in Mr. Howchin's paper on the Foraminifera of that locality ('Trans. Roy. Soc. S. Australia,' vol. xii, 1889).

3. Textilaria subflabelliformis, *Hantken*, 1875. Plate V, fig. 21.

Textilaria subflabelliformis, *Hantken*, 1875 (1881). Mitth. Jahrb. Ung. Geol. Anstalt, vol. iv, p. 66, pl. xv, fig. 2.

This form is closely allied to *T. sagittula*, but shorter and broader. Von Hantken's illustration (fig. 2) is a good counterpart of our fig. 21. Fornasini figures the nearly allied *T. unita*, 'Boll. Soc. Geol. Ital.,' vol. vi, 1887, p. 397, pl. x, figs. 2, 2 *a*, 2 *b*, differing from our specimen in being larger, thicker, and narrower, and therefore less broadly triangular. Both of these have the style of growth of *T. sagittula* as to the setting-on of the chambers, which are nearly horizontal and compact; but extending laterally they give a greater breadth to the shell. This form is short in growth, and whether it be young or dwarf is doubtful.

*Textilaria flabelliformis*, Gümbel, 1868, 'Abhandl. Akad. Bayer.,' vol. x, p. 647, pl. ii, figs. 83 *a*, *b*, having limbate sutures, is analogous, in this respect, to the var. *jugosa* of *T. sagittula*. It is otherwise similar to von Hantken's fig. 2, except that its chambers are curved. Fornasini, in the 'Boll. Soc. Geol. Ital.,' vol. vi, 1887, p. 400, pl. xi, figs. 2, 2 *a*, has illustrated a "short form of *T. sagittula*," which has the upper edges of the chambers thickened so as to form a limbation, as in var. *jugosa*. Except for this feature it would be *subflabelliformis*.

*Occurrence*.—The specimen of *Textilaria subflabelliformis*, Pl. V, fig. 21, is in the Searles-Wood Collection in the British Museum, and was probably obtained from Sutton. We have not noted its occurrence in other exposures of the Coralline Crag.

4. Textilaria agglutinans, *d'Orbigny*, 1839. Plate III, figs. 14—16.

Part I, 1866, Appendix II, Table, No. 61.

Textularia agglutinans, *d'Orb.*, 1839. Foram. Cuba, p. 144, pl. i, figs. 17, 18, and figs. 32—34.

Textilaria parallela, *Reuss*, 1860. Sitzungsb. k. Akad. Wien, vol. xl, p. 233, pl. xii, figs. 7 *a*, *b*.

— concinna, *Reuss*, 1860. Ibid., vol. xl, p. 233, pl. xiii, figs. 1 *a*, *b*.

— conulus, *Reuss*, 1860. Ibid., vol. xl, p. 231, pl. xiii, figs. 3 *a*, *b* (short form of *T. agglutinans*).

Textilaria pupa, *Reuss*, 1860. Sitzung. k. Akad. Wien, vol. xl, p. 232, pl. xiii, figs. 4 *a*, *b*, and 5 *a*, *b* (shortest form).

— Partschii, *Reuss*, 1860. Ibid., vol. xl, p. 233, pl. xiii, figs. 6 *a*, *b*.

— — *Seguenza*, 1862. Atti Accad. Gioenia, ser. 2, vol. xviii, p. 114, pl. ii, figs. 4, 4 *a*.

— agglutinans, *Parker and Jones*, 1863. Ann. Mag. Nat. Hist., ser. 3, vol. xi, pp. 91, 93, and 97.

— — var., *Jones*, 1863. Geologist, vol. vi, p. 294, pl. xv, figs. 4, 5. (Having subglobose chambers more loosely arranged than in the type, and fig. 5 is flexed.)

Plecanium Sturi, *Karrer*, 1864. Sitzungsb. k. Akad. Wien, vol. i, p. 703, pl. i, fig. 1.

Textularia agglutinans, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 369, pl. xv, figs. 21 *a*, *b*. (A thick, blunt form.)

— — *J., P., and B.*, 1866. Monogr. Foram. Crag, Tables, Appendices I and II.

Plecanium agglutinans, *Reuss*, 1869. Sitzungsb. k. Akad. Wien, vol. lix, p. 452, pl. i, figs. 1 and 2.

Textilaria agglutinans, *Moebius*, 1880. Foram. Mauritius, p. 93, pl. ix, figs. 1—8. (Structure well described.)

Textularia agglutinans, *Hamilton*, 1881. Transact. New-Zealand Institute, vol. xiii, p. 395, pl. xvi, fig. 10.

— — *Brady*, 1884. Report 'Challenger,' p. 363, pl. xliii, figs. 1—3; and var., figs. 4 and 12.

— — *Woodward and Thomas*, 1884. 13th Report Geol. N. H. Surv. Minnesota, p. 167, pl. iii, figs. 6 and 7.

— — *Vine*, 1885. Proc. Yorksh. Geol. Soc., N. S., vol. ix, No. 1, p. 28, pl. ii, fig. 17.

— — *Sherborn and Chapman*, 1886. Journ. R. Micr. Soc., ser. 2, vol. vi, p. 742, pl. xiv, figs. 6 *a*, *b*.

— — ? *Malagoli*, 1887. Boll. Soc. Geol. Ital., vol. vi, p. 520, pl. xiii, fig. 2.

— — *Toutkowsky*, 1888. Zapisk. Kievsk., vol. ix, p. 9, pl. ix, figs. 3 *a—c*.

— — *B., P., and J.*, 1888. Trans. Zool. Soc., vol. xii, No. 7, p. 219, pl. xli, figs. 17 and 23; pl. xlii, figs. 2 and 3.

— — *Haeusler*, 1890. Abhandl. Schweiz. Paläont. Ges., vol. xvii, p. 71, pl. xi, figs. 1—9, 11—16, 47—50, and 52. (Including some modifications.)

— *Chapman*, 1892. Journ. R. Microsc. Soc., p. 329, pl. vi, fig. 21.

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|---|---|---|---|
| Textularia agglutinans, | *Egger*, | 1893. | Abhandl. k. Akad. Bayer., vol. xxviii, part 2, p. 267, pl. vi, figs. 1 and 2. (Thick, trochoid.) |
| — | — | *Goës*, 1894. | K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 35, pl. vii, figs. 281—284, 294—303. (Fig. 300 seems to be typical, the others varieties.) |

*Characters.*—Shell elongate, conical, suboblong in section; chambers more or less horizontal and compact, presenting a broad or narrow pentagonal aspect on the sides of the shell. The chamber-cavities liable to subdivision by secondary septa (see fig. 16), which form barred apertures. Shell-wall consisting of agglutinated sand-grains.

This form, which we regard as the type of the genus, is variable in its features to a considerable extent. Extreme forms are illustrated by the tapering and slightly flexed fig. 14 of Pl. III; the short subcylindrical form in the 'Phil. Trans.,' 1865, pl. xv, fig. 21; and the longer subcylindrical *T. parallela*, Reuss; the compressed *T. lævigata*, d'Orb., and *T. concinna*, Reuss, and the shorter *T. conica* and *pupa*, passing into *T. Partschii*, which is evidently related to *T. gibbosa* and *tuberosa*, d'Orb. On the other hand, *T. agglutinans* may be compressed, as *Plecanium eocænum*, Gümbel.

D'Orbigny's figures, from recent examples, very much resemble our Pl. III, figs. 14, 15, the latter being perhaps a little rougher and more irregular; but proportionately shorter specimens are often met with. The labyrinthic condition shown in section in fig. 16 is not uncommon in other varieties of the genus, under circumstances favorable to the production of large free-growing specimens. A similar state of the terminal orifice is one of the peculiar characters of the tropical *Textilaria Barrettii*.

*Occurrence.*—*Textilaria agglutinans* is found in all seas and at all depths; the lowest recorded depth is 3125 fathoms. The geological range of this species has lately been shown to extend from the Neocomian (Bargate Beds) of Surrey (Chapman). It has been found also in the Gault of Folkestone, the Red Chalk of Speeton, the White Chalk, the Eocene London Clay, the Oligocene of Elsass, the Miocene of Vienna and of Muddy Creek in Victoria, the Older Tertiaries of South Australia (Howchin), the Helvetian and Plaisancian beds of Italy (de Amicis), and in the Pleistocene of Sicily (Seguenza). We have found specimens in every zone of the Coralline Crag examined except at Tattingstone. In Mr. S. V. Wood's Sutton gatherings the specimens are numerous and large.

4*. Textilaria agglutinans, *d'Orb.*, Var. densa, nov. Plate VI, figs. 17 *a*, *b*.

Textularia agglutinans, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 369, pl. xv, fig. 21.

*Characters.*—Shell subcylindrical, thick, tapering to the blunt aboral apex; somewhat compressed, and with the transverse section ovate; chambers numerous, compact, narrow in side view, and horizontal.

This belongs to the *agglutinans* type, as represented by the thick Arctic form figured in the 'Phil. Trans.,' 1865, pl. xv, fig. 21, which, however, is relatively smaller, rather more compressed, and tapers more rapidly to the apex, having widened more rapidly in growth. Both of these forms approach the *T. gramen* type in their relative compression, having produced a subacute edge on at least one margin; in *T. gramen*, d'Orb., the chambers are oblique, and both edges are sharp.

Analogies may be found for this varietal form among *T. trochus*, *T. turris*, and *T. Barrettii;* but in detail these *Textilariæ* differ considerably.

*Occurrence.*—*Textilaria agglutinans*, var. *densa*. The specimen figured, Pl. VI, fig. 17, was found at Broom Hill, zone **d**.

5. Textilaria trochus, *d'Orbigny*, 1840. Plate III, figs. 17, 18.

Part I, 1866, Appendix II, Table, No. 62.

Textularia trochus, *d'Orbigny*, 1840. Mém. Soc. Géol. Fr., vol. iv, p. 45, pl. iv, figs. 25, 26.
— — *Reuss*, 1845. Geinitz's Grundriss, &c., p. 681, pl. xxiv, fig. 76.
— cuneiformis, var. conica, *Williamson*, 1858. Rec. For. Gt. Br., p. 75, pl. vi, figs. 160, 161.
— trochus, *Eley*, 1859. Geol. Garden, p. 199, pl. vi, fig. 34.
— — *Parker and Jones*, 1860. Quart. Journ. Geol. Soc., vol. xvi p. 302 (table).
— — *Iidem*, 1862. In Carpenter's Introd., App., p. 311.
— — *Jones*, 1863. Geologist, vol. vi, p. 294, pl. xv, fig. 3.
— — *Brady*, 1864. Trans. Linn. Soc., vol. xxiv, p. 473.
— cuneiformis, var. conica, *Alcock*, 1864. Proc. Lit. Phil. Manchester, vol. iv, p. 206.
— trochus, *Brady*, 1865. Nat. Hist. Trans. North. and Durham, vol. i, p. 112.
— — *J., P., and B.*, 1866. Monogr. Foram. Crag, Appendix II, Table, No. 62.

Textularia trochus, *Vanden Broeck*, 1876. Ann. Soc. Belg. Microsc., vol. ii, p. 132, pl. iii, figs. 11, 12.

— — *Goës*, 1882. K. Svensk. Akad. Handl., vol. xix, p. 80. (Pl. v, figs. 153—158, referred by Dr. Goës to *T. sagittula*, appear to belong to *T. trochus*.)

— — *Brady*, 1884. Report 'Challenger,' p. 366, pl. xliii, figs. 15—19; pl. xliv, figs. 1—3. (Limbate or lipped.)

— — *Agassiz*, 1888. Cruises 'Blake,' vol. ii, p. 165, fig. 501.

— — *Terrigi*, 1889. Atti Lincei Mem., ser. 4, vol. vi, p. 18, pl. v, fig. 4. (Chambers flatter; shell neatly conical.)

— — *Burrows, Sherborn, and Bailey*, 1890. Journ. R. Micr. Soc., p. 553, pl. viii, fig. 14.

— — *Haeusler*, 1890. Abhandl. Schweiz. Pal. Ges., p. 72, pl. xi, figs. 43, 44. (Very broad and flat.)

— — *Chapman*, 1892. Journ. Micr. Soc., p. 328, pl. vi, fig. 18.

— — *Egger*, 1893. Abhandl. k. Ak. Bayer., vol. xxviii, part 2, p. 273, pl. vi, figs. 37, 38. (With lipped or limbate chambers.)

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, pp. 50, 180, 181, 340.

*Characters.*—Shell short, conical, trochoid, sides rounded; anterior surface circular, and flat or concave. Sutures but little, if at all, excavated. Chambers horizontal, narrow. Texture variable, often rough. This is one of the most symmetrical of the *Textilariæ*.

The only feature by which this species may be distinguished from short specimens of *T. sagittula* is its circular contour; and though the amount of compression in the latter species is, as might be supposed, a very variable character, *T. trochus* still represents a tolerably well-defined group. D'Orbigny's figure is a somewhat idealised representation of the shell, and indicates a much neater and more compact build than is usually seen in nature.

*Plecanium Speyeri*, Reuss, 1864, 'Sitzungsb. Ak. Wien,' vol. l, p. 449, pl. i, fig. 3, conical, slightly compressed, with horizontal chambers, is near *T. trochus*.

*Occurrence.* — *Textilaria trochus* has a wide geographical range, and is particularly abundant amidst coral sands of tropical and subtropical latitudes. It is a common Cretaceous fossil,—the species was originally described by d'Orbigny from the White Chalk of the Paris Basin. Its range has lately been shown to extend from the Neocomian (Bargate Beds) of Surrey (Chapman). Other localities from which it has been obtained are the Gault of Folkestone, the Red Chalk of Speeton, the Chalk-marl of Charing (where the species is particularly well developed), the Upper Chalk of Taplow, the Pliocene of Garrucha, and the Pleistocene of Sicily. We have specimens from the Miocene of Muddy Creek,

Victoria. In the Crag the species is not common. It has been found at Sutton; Broom Hill, zones **d** and **e**; Aldborough, zone **g**; Tattingstone, zone **d**; and at Sudbourne Hall, zone **d**, where the species is more common and better developed.

6. Textilaria conica, *d'Orbigny*, 1839. Plate VII, fig. 24.

Textularia conica, *d'Orb.*, 1839. Foram. Cuba, p. 135, pl. i, figs. 19, 20.
— — *Brady*, 1884. Report 'Challenger,' p. 365, pl. xliii, figs. 13, 14; pl. cxiii, figs. 1 *a*, *b*.
— — *Haeusler*, 1890. Abhandl. Schweiz. Pal. Ges., p. 72, pl. xi, figs. 40—42, 45.
— — *Chapman*, 1892. Journ. Royal Microsc. Soc., p. 329, pl. vi, fig. 20. (Somewhat irregular with the last two chambers.)
— — *Egger*, 1893. Abhandl. k. Akad. Bayer., vol. xxviii, part 2, p. 273, pl. vi, fig. 35.

*Characters.*—Shell short, tapering rapidly to the apex, triangular in outline, more or less compressed, and varying from round to oval in transverse section; chambers horizontal, depressed, narrow in side view.

This may be regarded as a feeble form of *T. trochus*, rather irregular in its growth, and oval in section.

*Occurrence.*—*Textilaria conica* is a tropical form, commonest perhaps on the coral reefs of the Eastern Archipelago and the West Indies. Specimens were obtained by the "Challenger" from depths varying from 18 to 420 fathoms. There are few records of the occurrence of the species in a fossil condition. It has been noted from the Upper Chalk of Taplow (Chapman). The Crag specimens were obtained with varying frequency from nearly every zone examined. It is most common at Sudbourne Hall, zone **d**.

7. Textilaria gibbosa, *d'Orbigny*, 1826. Plate III, figs. 10—13; and Plate V, figs. 13 and 14.

Part I, 1866, Appendix II, Table, No. 63.

Polymorpha pineiformia, *Soldani*, 1791. Testaceographia, vol. i, part. 2, p. 118, pl. cxxvii, fig. H.
— janiformia, *Idem*. Ibid., p. 119, pl. cxxxii, figs. I, K, L, M; and vol. ii, p. 39, pl. xiv, fig. *h*.
Nautili amphorarii vel janiformes, *Idem*, 1798. Ibid., App., p. 141, pl. 7, figs. 46 *e*, E.
} [1]

[1] These rough and often obscure figures appear to have reference to *Textilariæ* more or less closely allied to *T. gibbosa*, d'Orb.

Textularia gibbosa, *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 262, No. 6; Modèle, No. 28.

— obtusa, *Idem*. Ibid., p. 262, No. 1.

— lævigata, *Idem*. Ibid., p. 262, No. 2.

— punctulata, *Idem*. Ibid., p. 262, No. 4.

— Partschii, *Czjzek*, 1848. Haidingers Nat. Abhandl., vol. ii, p. 148, pl. xiii, figs. 22—24.

Textilaria pupa, *Reuss*, 1860. Sitzungsb. k. Akad. Wiss. Wien, vol. xl, p. 232, pl. xiii, fig. 5 only (not fig. 4). (= short, gibbose.)

Textularia gibbosa, *Parker and Jones*, 1860. Quart. Journ. Geol. Soc., vol. xvi, p. 302 (Table).

Textilaria minima, *Karrer*, 1865. Novara-Exp. Geol. Th. Pal., p. 79, pl. xvi, fig. 9. (Short form.)

Plecanium Karreri, *Stache*, 1864. Ibid., p. 178, pl. xxi, fig. 17.

— granosissimum, *idem*. Ibid., p. 179, pl. xxi, fig. 18.

— eurystoma, *idem*. Ibid., fig. 19.

Textularia gibbosa, *P., J., and B.*, 1865. Ann. Mag. N. H., ser. 3, vol. xvi, p. 23, pl. ii, fig. 60.

— — *Iidem*, 1866. Monogr. Foram. Crag, Appendix II, Table, No. 63.

Textilaria ovalis, *Kübler and Zwingli*, 1866. Neujahrsblatt, &c., p. 19, pl. iii, Untere Kreide, fig. 6.

— Zwinglii, *Zwingli and Kübler*, 1870. Foram. Schweiz. Jura, p. 30, pl. iii, fig. 44.

Textularia gibbosa, *Brady*, 1876. Monogr. Carb. Perm. Foram., Pal. Soc., p. 131, pl. x, figs. 26 *a*, *b*. (With a list of synonyms.)

Plecanium gibbum, *Zittel*, 1876. Palæont., vol. i, p. 89, fig. 26.

Textularia gibbosa, *Fornasini*, 1886. Boll. Soc. Geol. Ital., vol. v, pp. 116, 275, 276.

— — *Idem*, 1887. Ibid., vol. vi, fasc. 2, p. 160 (with synonyms), pl. ii, figs. 1 *a*, *b*.

— — *Idem*, 1887. Ibid., vol. vi, p. 160, pl. ii, figs. 1, 1 *a*, 1 *b*.

— agglutinans? *Malagoli*, 1887. Ibid., vol. vi, p. 520, pl. xiii, fig. 2.

— gibbosa, *Haeusler*, 1890. Abhandl. Schweiz. Pal. Ges., vol. xvii, p. 71, pl. xi, figs. 28—36.

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, pp. 46, 180, 181, 236.

— — var. transcendens, *Idem*. Ibid., p. 237, pl. iii, fig. 5.

— Partschii, *Egger*, 1893. Abhandl. k. Ak. Bayer., vol. xxviii, part 2, p. 267, pl. vi, figs. 22, 23 (triangular and tapering each way).

*Characters.*—Shell subtriangular, tapering, constricted at the sutures, depressed along the line of the juxtaposition of the two series of chambers. Margin rounded. Chambers ventricose. Texture coarse.

The bold, coarse-shelled *Textilariæ* with gibbose or subglobular chambers, and of somewhat irregular growth, commoner as Tertiary fossils than in the recent condition, form a natural group between the more delicate and regular *T. globulosa*, Ehrenberg, and the thick and coarse forms of *T. agglutinans*.

It is not uncommon to meet with specimens in which the chambers are subdivided into chamberlets, as shown in two of our figures (Pl. III, fig. 12, and Pl. V, fig. 13). Another but much less frequent variation from the normal habit is represented in the double shell found in one of the Sutton gatherings, Pl. III, fig. 13.

*T. gibbosa* has many analogues in the sharp-edged forms known as *T. subangulata*, *gramen*, and *abbreviata*, d'Orb., and their numerous allies. These become *gibbosa* by being less compressed, their chambers sloping less, and their lateral edges more rounded.

*Bigenerina patula*, Brady, 1876, 'Monogr. Carb. Perm. Foram.,' p. 136, pl. viii, figs. 10, 11, and pl. x, figs. 30, 31 (afterwards *Climacammina*, *in literis*), is a bigenerine *gibbosa*, with its chambers subdivided into labyrinths.

About fourteen fossil specimens of *Textilaria gibbosa*, d'Orb., are figured in Ehrenberg's memoirs under various names; see 'Ann. Mag. Nat. Hist.,' ser. 4, vols. ix and x, 1872, especially p. 456; and occasionally Ehrenberg illustrated recent specimens, op. cit., pp. 222 and 254.

*Occurrence.*—*Textilaria gibbosa*. No recent specimen of this form is recorded in the 'Challenger' Report, but it is noted ('Quart. Journ. Geol. Soc.,' vol. xvi, 1860, Table, p. 302) as occurring at Venice (on the Lido) and at Rimini (Adriatic). Fossil specimens have been found in the Gault of Folkestone, in the White Chalk, the Miocene of Vienna, of Malaga, and of Muddy Creek (Victoria); the older Tertiaries of South Australia (Howchin), and the Helvetian of Italy (de Amicis). In the Coralline Crag *T. gibbosa* is one of the commonest and best developed of the *Textilariinæ*. The specimens obtained from Sutton, zone **f**, and Sudbourne Hall, zone **d**, are particularly fine.

8. Textilaria tuberosa, *d'Orbigny*, 1826. Pl. V, fig. 17.

Polymorphum janiforme,[1] *Soldani*, 1798. Testaceogr., &c., vol. ii, pp. 39 and 45, pl. xiv, fig. *h*.

[1] Among the many misprints in d'Orbigny's "Tableau méthodique," &c., in the 'Ann. Sci. Nat.,' vol. vii, the reference at p. 263 to "Sold. 4, p. 39, Tab. 14, fig. *H*, *Polymorphium* [sic] *tuberosum*," is one of the most misleading. The "Polymorpha tuberosa" of vol. i, part 3, p. 39, are described by Soldani as figured under "*f*, *g*," in pl. xiv, from the vase cxxvi: fig. *h*, of pl. xiv, from the vase cxxvii, and referred to by Soldani, at pp. 39 and 45, as one of the "janiformia," is evidently the one quoted by d'Orbigny as "fig. *H*," and named by him *Text. tuberosa* under a mistake, and without carefully reading the text.

Textularia tuberosa, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 263, No. 26.
— clypeata, *Costa*, 1856. Atti Accad. Ponton., vol. vii, p. 295, pl. xxiii, fig. 4.
Plecanium tuberiforme, *Seguenza*, 1880. Atti Accad. Lincei, ser. 3, vol. vi, p. 152, pl. xiv, fig. 9.
Textularia punctulata, *Fornasini*, 1883. Boll. Soc. Geol. Ital., vol. iii, p. 182.
— tuberosa, *Idem*, 1887. Ibid., vol. vi, p. 161, pl. ii, figs. 2, 2 *a*, 2 *b*.
— — *de Amicis*, 1893. Ibid., vol. xii, fasc. 3, pp. 45, 180, 181.

Subovate; chambers neat and small at first, swollen afterwards; not so compact as in *gibbosa*, nor enlarging so rapidly with their growth, and therefore forming a less broadly triangular shell. At p. 169, 'Ann. Mag. Nat. Hist.,' ser. 4, vol. viii, 1871, pl. xi, fig. 119, *Textilaria tuberosa* is referred to as "belonging probably to *T. gibbosa*." So also *T. obtusa*, *lævigata*, and *punctulata*, d'Orb., are combined with *T. gibbosa* (ibid., p. 167, pl. xi, figs. 115—117).

*Occurrence.*—This species, founded by d'Orbigny on a figure given by Soldani, is not recorded in the 'Challenger' Report as occurring in the recent condition. Fossil specimens have been recorded from the Pliocene of Tuscany and the Miocene of Sardinia (de Amicis). The Crag specimen figured on Pl. V, fig. 17, is in the Searles-Wood Collection, British Museum, and was obtained from Sutton.

9. Textilaria globulosa, *Ehrenberg*, 1838. Plate VI, figs. 18 *a*, *b*, *c*.

Textilaria globulosa, *Ehrenb.*,[1] 1838. Abhandl. Preuss. Akad. Wiss., 1838, p. 135, pl. iv, fig. *β*.
Textularia globulosa, *Bailey*, 1843. In Hitchcock's Reports I, II, III, Assoc. Americ. Geol. and Nat., 1843, p. 357, pl. xv, figs. 1, 3, 4, 5, 7.
— — *Reuss*, 1845. Böhm. Kreidef. I, p. 39, pl. xii, fig. 23.
— — *Idem*, 1846. In Geinitz's Grundriss, &c., p. 681, pl. xxiv, fig. 74.

[1] This species is represented under various appellations in Ehrenberg's 'Mikrogeologie,' 1854,—pl. xxiii, figs. 3—6; pl. xxiv, figs. 12—14; pl. xxv, I A, figs. 9—11; pl. xxv, III C; pl. xxvii, fig. 6; pl. xxviii, figs. 9, 10; pl. xxix, fig. 17; pl. xxx, fig. 3 *a*; pl. xxxi, figs. 12, 13; pl. xxxii, II, figs. 12, 13; pl. xxxvii, VI, figs. 6, 7; 'Abhandl. Preuss. Akad. Wiss.,' 1856, p. 161, pl. ii, fig. 1. These are referred to in detail in the 'Ann. Mag. Nat. Hist.,' ser. 4, vol. ix, 1872, pp. 280, 284, 287, 289, 292, 298; vol. x, 1872, pp. 185, 188, 193, 197. In vol. ix, at pp. 222, 223, 255, 257, and 264, some miscellaneous occurrences are also noticed of this little organism, recent and fossil, as figured by Ehrenberg. A full synonymy of this species will be published in the second part of C. D. Sherborn's 'Index of the Genera and Species of Foraminifera,' which the Smithsonian Institution will issue this year.

Textillaria globulosa, *Williamson*, 1847. Mem. Lit. Phil. Soc., Manchester ser. 2, vol. viii, p. 76, pl. [4], fig. 61 (var. slightly irregular).

— gibbosa, *Idem*, 1872. Ibid., ser. 3, vol. v, p. 136.

Textularia globulosa, *Harting*, 1849. Magt. Kleine, p. 119, figs. 5 and 8; 1851 (German ed.), p. 87, fig. 39.

— — *Mantell*, 1854. Medals of Creation, 2nd edit., vol. i, p. 342, fig. 1092.

Textilaria globifera, *Reuss*, 1860. Sitzungsb. k. Akad. Wien, vol. xl, p. 232, pl. xiii, fig. 8 (not fig. 7).

— globulosa, *Bronn*, 1853–6. Lethæa, &c., 3rd edit., vol. iii, p. 235, pl. xxxv, figs. 32 *a*, *b*.

Textularia striato-punctata, *Egger*, 1857. N. Jahrb., &c., p. 294, pl. iii, figs. 27, 28 (ornamented).

— globulosa, *Eley*, 1859. Geology in the Garden, pp. 194 and 201, pl. ii, fig. 9; pl. vii, figs. 39, 39 *c*; pl. ix, fig. 9 *c*.

[ — — ] *Hitchcock*, 1860. Elem. Geol., 30th edit., p. 382, figs. 203 (two), 204 (one), 205 (one), 207 (one); p. 383, fig. 308 (one).

— — *Heer*, 1865. Urwelt Schweiz, vol. i, p. 197, fig. 109; 1876, Engl. edit., p. 207, figs. 109 *a*—*d*.

— — *Hartwig*, 1866. The Sea, &c., 3rd edit., p. 381, fig. *f*.

Textilaria gigas, T. inæquilateralis, et T. globigerina, *Kübler and Zwingli*, 1866. Neujahrsblatt, &c., p. 18, pl. iii, figs. 9, 12, and 13.

Textularia globulosa, *Brady*, 1870. Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 300, pl. xii, figs. 4 *a*, *b*.

Bolivina, Nos. 507 and 508, *Schlicht*, 1870. Foram. Sept. Pietzpuhl, p. 87, pl. xxxiii, figs. 27 and 28, and figs. 29 and 30 (irregular in growth). Referred to *T. globifera* by Reuss.

Textularia globulosa, *Greene*, 1871. Manual Protozoa, p. 15, fig. 3 *f*.

— — *G. M. Dawson*, 1874. Canad. Nat., ser. 2, vol. vii, p. 253, fig. 1 *a* (striate).

— gibbosa, var. globulosa, *Idem*, 1875. Report Geol. Forty-ninth Parallel, p. 79, pl. xvii, fig. *a* (striate).

— globifera, *Zittel*, 1876. Handb. Paläont., I, p. 90, fig. 27 (striate).

— globulosa, *Morris*, 1876. Lecture Croydon, p. 8, fig. 3 *a*.

— — *J. W. Dawson*, 1876. Proceed. Am. Assoc. for 1875, p. 103, fig. 4 *a* (striate).

Textilaria globulosa, *Schwager*, 1877. Boll. Com. Geol. Ital., vol. viii, p. 26, pl. 0, fig. 60 (striate).

Textularia globulosa, *Anon.*, 1883. Amer. Cyclop., vol. vii, p. 311, fig. 1.

Textilaria gracillima, *Andreae*, 1884. Abhandl. Geol. Special-Karte Elsass-Lothringen, vol. ii, Heft 3, p. 235, pl. viii, fig. 9 (long var.).

Textularia globulosa, *Woodward and Thomas*, 1885. 13th Report Minnesota, p. 166, pl. iii, figs. 1—6.

— gibbosa, *Malagoli*, 1887. Atti Soc. Nat. Modena (Rend.), ser. 3, vol. iii, p. 108, pl. i, fig. 2.

*Characters.*—Test consisting of globose chambers, arranged as an inverted cone, varying among individuals in the relative width of the parallel alternate series. Many small specimens widen out quickly, and have but few chambers above the first; others grow on with many chambers, more closely set, in a slowly tapering cone (such as *T. gracillima*, Andreae; and the still more attenuate *T. elongata*, Cornuel); others of medium size and proportions, losing the roundness and distinctness of the segments, pass into *T. gibbosa*, d'Orb.

*Occurrence.—Textilaria globulosa.*—This species, described by Ehrenberg, has a wide geographical range, chiefly in the Cretaceous series. The localities whence the specimens figured by Ehrenberg were obtained are—Cretaceous, Egypt, Syria, Arabia (?), France, England, Islands of Möen and Rügen in the Baltic, Bohemia, Russia, and Missouri; Eocene, Egypt and Bavaria; also from volcanic mud in the Eastern Archipelago, and from wind-dust at Malta, Lyons, and Silesia or Austria. Dr. H. B. Brady has recorded it as occurring in a brackish tidal pond at Westport, Ireland. It is a common Cretaceous fossil, being recorded from the Chalk of Swanscombe (zone of *Micraster cor-testudinarium*), from the Chalk of Taplow (zone of *Belemnitella quadrata*), from the Chalk of Westphalia, by Reuss, under the name *T. globifera*, by Andreae, from the Oligocene of Elsass, under the name *T. gracillima*; and recently by Millett from the Pliocene of St. Erth. Only one specimen has been met with in the Crag, and that in the Chillesford Beds of Aldeby, near Beccles.

## *Genus* 2.—Bigenerina, *d'Orbigny*, 1826.

*Brady, Report 'Challenger,' 1884, pp. 68 and 368.*

*Synonyms:*

Nautilus, pars, *Batsch.*
Orthoceras, pars, *Soldani.*
Bigenerina, *d'Orb., Römer, Reuss, Costa, Parker and Jones, Karrer, Brady, Schwager, M. Sars, Vanden Broeck, Winther, Terrigi, Bassett, Malagoli, Goës, Fornasini*, and others.
Gemmulina, *d'Orbigny.*
Vulvulina, pars, *d'Orb., Reuss.*
Clavulina, pars, *d'Orb., Karrer.*
Grammostomum, *Reuss, P. and J., Brady.*
Polymorphina, pars, *Ehrenberg.*
Textularia, *Goës.*

Schizophora, *Reuss, Hantken, Karrer, Sequenza, Schlumberger.*
Venilina, *Gümbel.*
Climacammina, *Brady, Schwager.*
Stylolina ? *Karrer.*
Cribostomum, pars, *Möller.*

*General Characters.*—Textilarian; dimorphous, being biserial in early growth and uniserial in a straight line afterwards; aperture terminal, round, and sometimes pouting.

1. Bigenerina nodosaria, *d'Orbigny*, 1826. Plate III, fig. 19 (*Verneuilina communis*).

Part I, 1866 (*Verneuilina communis*), Appendix II, Table, No. 65.

Bigenerina nodosaria, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 261, No. 1, pl. xi, figs. 9—12; Modèle No. 57.
— pusilla, *Römer*, 1838. N. Jahrb. für Min., &c., p. 384, pl. iii, fig. 20.
— agglutinans, *d'Orb.*, 1846. For. Foss. Vienne, p. 238, pl. xiv, figs. 8—10.
— nodosaria, *Reuss*, 1846. In Geinitz's Grundr. Verstein., p. 677, pl. xxiv, fig. 67.
— torulosa, *Costa*, 1856. Atti Accad. Pont., vol. vii, p. 285, pl. xv, fig. 12.
— annulata, *Idem.* Ibid., p. 284, pl. xv, fig. 13.
— bifida, *Idem.* Ibid., p. 287, pl. xxiii, fig. 1.
— nodosaria, *P. and J.*, 1863. Ann. Mag. Nat. Hist., ser. 3, vol. xi, p. 97.
Clavulina elegans, *Karrer*, 1864. Novara-Exped. Geol. Theil, vol. i, p. 80, pl. xvi, fig. 11.
Bigenerina nodosaria, *Reuss*, 1865. Model No. 58. (Catal. No. 12, 1861.)
— — *P., J., and B.*, 1865. Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 28, pl. ii, fig. 62.
Textularia agglutinans, var. (Bigenerina) nodosaria, *P. and J.*, 1865. Phil. Trans., vol. clv, p. 371, pl. xv, fig. 25; and pl. xvii, fig. 80.
Verneuilina communis, *J., P., and B.*, 1866. Monogr. Foram. Crag, No. 65, Table, Appendix II.
Bigenerina nodosaria, *Terrigi*, 1880. Atti Accad. Pont., ann. xxxiii, p. 192, pl. ii, fig. 28.
Textularia gibbosa, forma Bigenerina, *Goës*, 1882. K. Svensk. Vet. Akad. Handl., vol. xix, No. 4, p. 79, pl. v, figs. 162—164.
Bigenerina agglutinans, var. nodosaria, *Jones*, 1883. In Microgr. Dict., ed. 4, p. 96, pl. xiii, figs. 50 *a*, *b*.
— nodosaria, *Brady*, 1884. Report 'Challenger,' p. 369, pl. xliv, figs. 14—18.

BIGENERINA NODOSARIA, *Basset*, 1885. Acad. Rochelle; Soc. Sci. Nat. Charente. Inf.-Annales de 1884, No. 21, p. 161, and fig. 57 (d'Orbigny's model).

— — *Malagoli*, 1887. Atti Soc. Nat. Modena (Rend., ser. 3, vol. iii, p. 108, pl. i, figs. 3 and 4.

— — *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 52, 180, 181.

— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 37, pl. vii, figs. 313—323.

— — *Fornasini*, 1894. Coll. Soldani, Sagg. Oritt., p. 16.

*Characters.*—Initial part of the shell more or less triangular in outline, varying in relative size, and nearly always distinct from the succeeding moniliform series. Test variable in regularity of form, and in the roughness of surface.

*Occurrence.*—Most common in shallow waters of the North Atlantic. Fossil in the Middle and Upper Tertiaries. Rare at Sutton.

## *Genus* 3.—SPIROPLECTA, *Ehrenberg*, 1845.

*Berichte Berliner Akad. Wiss. for* 1844, *p.* 75. *Brady, Report 'Challenger,'* 1884, *pp.* 68 *and* 375.

TEXTILARIA, *Ehrenberg*.
HETEROHELIX, *Ehrenberg*.
SPIROPLECTA, *Ehrenberg, Parker and Jones, Brady, Balkwill and Wright, Bronn, Chapman, Millett, Woodward and Thomas, Halkyard*.
TEXTULARIA (pars), *Parker and Jones, Brady, Norman*.

*General Characters.*—A dimorphous Textilarian form; early segments planospiral, the following biserially alternate; the last not unfrequently uniserial. Test either hyaline or sandy.

### 1. SPIROPLECTA ROSULA, *Ehrenberg*, 1854. Plate VII, fig. 25.

SPIROPLECTA ROSULA, *Ehrenberg*, 1854. Mikrogeologie, Inhalt des Atlas, p. 24, pl. xxxii, II, fig. 26.

TEXTULARIA COMPLEXA, *Brady*, 1865. Nat. Hist. Trans. Northumb. Durham, vol. i, p. 101, pl. xii, figs. 6 *a*, *b*; and Rep. 'Chall.,' 1884, p. 377, foot-note.

SPIROPLECTA DEMERSA, *Ehrb.*, 1873. Abhandl. Berliner Akad. Wiss. for 1872, p. 247, pl. vii, fig. 26.

— NANA, *Ehrb.*, 1873. Ibid., p. 247, pl. v, fig. 17.

— ROSULA, *Egger*, 1893. Abhandl. k. Bayer. Ak.-Wiss., vol. xviii, Abth. II, p. 274, pl. vii, figs. 13, 14.

*Characters.*—A small hyaline Textilarian shell, beginning with a flat spire, and growing on with regular biserial chambers, making a narrow and somewhat compressed test, of uniform width, and with rounded edges.

The name *Spiroplecta rosula* was given by Ehrenberg to a (hyaline?) shell resembling in general contour the arenaceous form subsequently described by Parker and Jones ('Phil. Trans.,' 1865, vol. clv, p. 370, pl. xv, figs. 23, 24) under the name *Textularia agglutinans*, var. *biformis*.

On the same plate with *Spiroplecta rosula* in the 'Mikrogeologie,' Ehrenberg figured an allied form, but widening out in its growth (after the manner of *Text. gibbosa*) as *Sp. Americana*. This was at first regarded by him as a *Textilaria*, but its name was changed to *Heterohelix* in the 'Abhandl. Berliner Akad. Wiss.' for 1841 (1843), p. 429, No. 302; see also the 'Mikrogeol. Inhalt des Atlas,' 1854, p. 22. At page 24 of the same index it is referred to as *Spiroplecta Americana* from the Chalk of Missouri and Mississippi. It is doubtful if the test of this form and of *Sp. rosula* (also from the Chalk of Mississippi) is represented as hyaline or opaque in this plate; and Ehrenberg nowhere defines their shell-structure. Dr. H. B. Brady found that in recent specimens of *Sp. Americana* "the walls are thin and smooth, and in small specimens hyaline" (op. cit., p. 376). Clear-shelled forms like *Sp. rosula* have been found in existing seas. Of these recent "species," some mentioned above are *Sp. demersa*, Ehr., from the Philippines; and *Sp. nana*, Ehr., from Florida; of the latter there are (1) one of irregular growth, and (2) a young individual.

Other closely related hyaline forms are—

*Spiroplecta abyssorum*, Ehrenb., 1873. 'Monatsber. k. Preuss. Akad. Wiss.' for 1872, p. 293; 'Abhandl. Berl. Akad. Wiss.' for 1872, pp. 144 and 247 (Atlantic Telegraph-Line).

*Sp. Capensis*, Ehrenb., 1873. Ibid., p. 294; and ibid., p. 247 (Lagullas Bank).

*Sp. ? profundissima*, 1873. Ibid., p. 294 (Coral Sea). Imperfect individual.

Ehrenberg also noted and figured in 1856, 'Abhandl. Berl. Ak. Wiss.' (Physikal) for 1855, p. 169, pl. iv, fig. 13, a glauconitic cast of "*Spiroplecta* ——— ?" from the Zeuglodon Limestone of Alabama.

*Occurrence.*—Recent specimens of *Spiroplecta* are of rare occurrence, and are usually confined to the shallow waters of northern seas. These are, moreover, usually arenaceous; but the hyaline form, *S. rosula*, has been found on the north-east coast of England (Brady) and in the Philippine seas (Ehrenberg). In the fossil condition *S. rosula* has been recorded from the Cretaceous series of North America (Ehrenberg), and from the Pliocene beds of St. Erth (Millett). One specimen only has been found in the Coralline Crag, and that from Gedgrave, zone **f**.

## *Sub-family* 2.—Bulimininæ.

*Brady, Report 'Challenger,'* 1884, *pp.* 68, 355, *and* 397.

*General Characters.*—Typically spiral; sometimes biserial; aperture oblique, usually curved, and more or less comma-shaped.

### *Genus* 1.—Bulimina,[1] *d'Orbigny*, 1826.

*See also Brady, Report 'Challenger,'* 1884.

Bulimina, *d'Orbigny, Sander-Rang, Menke, Bronn, Römer, Reuss, Alth, Bailey, Schultze, Costa, Bornemann, Parker and Jones, Egger, Williamson, Karrer, Carpenter, Brady, M. Sars, Schwager, Gümbel, Hantken, Dawson, Prestwich, Terquem, Zittel, Terrigi, Goës, Stache, Alcock, Parfitt, Marsson, Seguenza, Wright, Eley, Pictet, Andreae, Sherborn, Chapman, Dana, Chimmo, Fornasini, Millett, and others.*

Textularia, pars, *d'Orb.*

Robertina, *d'Orbigny, Reuss.*

Rotalina, pars, *Reuss.*

Cucurbitina, pars, *Costa.*

Ataxophragmium, *Reuss, Karrer.*

Pulvinulina, pars, *Jones and Parker.*

Cassidulina, pars, *Brady.*

Polymorphina, pars, *Ehrenberg.*

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[1] At page 398 of the 'Report on the Foraminifera' collected during the voyage of the 'Challenger,' &c., 1884, the genus *Bulimina* is stated to have had a geological range from the "Upper Trias (Parker and Jones)" to the Tertiary and present times. This and similar statements about other genera and species in the Report, and in memoirs and papers by other workers, including the First Part of the Monograph of the Foraminifera of the Crag (page 48), is due to a mistake as to the real locality of some "Blue Clay," supposed to have come from the alabaster pits at Chellaston, Derbyshire. See the paper by T. R. Jones and W. K. Parker, "On some Fossil Foraminifera from Chellaston, near Derby," 'Quart. Journ. Geol. Soc.,' vol. xvi, 1860, pages 452—458, pls. xix and xx.

The "Triassic" age of these Foraminifera has always been doubted, and personal inquiries and search were made without definite results; but their unmistakable *Liassic* facies, and the doubts existing about the exactness of the workmen's statements, have led us to believe that this "blue clay" came from some Lias in Leicestershire, having probably been inadvertently thrown in with the "red clay" on its journey to Cubitt's works in London.

In the 'Journal of the Northamptonshire Natural-History Society,' vol. vii, 1892, page 68, Messrs. W. D. Crick and C. D. Sherborn referred to the probable Liassic character of the above-mentioned blue clay. In the 'Annuaire géologique universel,' vol. ix, 1894, p. 922, the editor observes, "This study permits of our fixing precisely the level of the 'blue clay of Chellaston,' which has been attributed to the Trias, the fossils being undoubtedly those of the Upper Lias."

*General Characters.*—Typically spiral, short or elongate; trochoid or subcylindrical; last convolution proportionally large; segments numerous, small at first, septal plane of each segment generally directed inwards towards the central umbilical axis, and rapidly increasing in size; aperture a simple loop-like slit, oblong; or arcuate in the septal face, and directed obliquely or vertically downwards, but sometimes nearly round; one of its lips passing behind the other at its umbilical margin. The chambers in the whorls may be many or few, inflated or compact; the convolution may be either produced or depressed, thus forming either a long or a short shell. The *Buliminæ* with arenaceous tests have been grouped under the name *Ataxophragmium* by von Reuss, 'Sitzungsb. Akad. Wiss. Wien,' vol. xliv, 1861, p. 383. See also Carpenter's 'Introd. Study Foram.,' Ray Soc., 1862, pp. 194—197.

1. Bulimina elegans, *d'Orbigny*, 1826. Woodcut, fig. 17.

Part I, 1866, Appendix II, Table, No. 66.

| | | |
|---|---|---|
| Bulimina elegans, *d'Orb.*, 1826. | Ann. Sci. Nat., vol. vii, p. 270, No. 10, Modèle No. 9. |
| [ — — ] *Costa*, 1838 (?). | Fauna R. Nap., Foram., pl. iii, fig. 6 *a*, a, b, c (not described). |
| — — *J. and P.*, 1860. | Quart. Journ. Geol. Soc., vol. xvi, p. 302, Table, No. 55. |
| — — *P., J., and B.*, 1865. | Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 20, pl. ii, fig. 64. |
| — — *J., P., and B.*, 1866. | Monogr. Foram. Crag, Appendix II, Table, No. 66. (The specimen from Chillesford here alluded to has been lost sight of.) |
| — — *Brady*, 1884. | Report 'Challenger,' p. 398, pl. l, figs. 1—4. |
| — — *Gümbel*, 1885. | Geol. Bayern., vol. i, pt. 2, pp. 421, 422, fig. 266, 19. |
| — — *Chapman*, 1892. | Quart. Journ. Geol. Soc., vol. xlviii, pp. 514, 516, 518, pl. xv, fig. 9. |
| — — *Egger*, 1893. | Abhandl. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 284 and 446, pl. viii, figs. 66 and 67. |

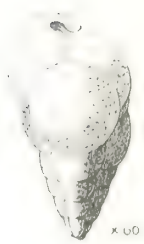


Fig. 17.—*Bulimina elegans*, d'Orb. × 60. Specimen from the Coralline Crag at Broom Hill, zone d.

*Characters.*—Test triserial, tapering, with numerous rather inflated chambers; acute below, obtuse above.

*Occurrence.*—*Bulimina elegans* is stated by Brady in the 'Challenger' Report to occur not uncommonly in the North and South Temperate Zones, at depths ranging from 11 to 1630 fathoms. In the tables at the end of the 'Challenger' Report no mention is made of the species. D'Orbigny's specimens were obtained from the Adriatic, near Rimini. The geological range of *B. elegans* extends back to the Chalk of Swanscombe and Taplow (Chapman). We have noticed no occurrence of the species in Tertiary formations older than the Pliocene, in which it has been recorded from the Italian beds. We have it in our own Collection from the Scaldisian of Antwerp.

In the Coralline Crag we have specimens from Sudbourne Hall and Broom Hill, zone **d**; Gedgrave, zone **f**; and Aldborough, zone **g**. In the Upper Crag the only record is from Chillesford, as indicated in the First Part of the Monograph.

1*. Bulimina elegans, *d'Orbigny*, 1826. Var. Plate VI, fig. 19.

Bulimina elegans [var.], *Brady*, 1884. Report 'Challenger,' p. 398, pl. 1, figs. 3, 4.

*Characters.*—The specimen shown by Pl. VI, fig. 19, is not so symmetrically tapering a form as is usual with *B. elegans*. In this respect it does not resemble Brady's figs. 1 and 2, but the more cylindric and clumsier figs. 3 and 4, which it will be convenient to regard as a varietal form.

Some closely related (zoologically identical) forms have been described and figured by G. Stache ('Novara-Exped., Geol. Theil.,' vol. i, part 2, Palæontology, 1866, pp. 265–7, pl. xxiv, figs. 13—16), varying chiefly in respect to size, and named *Bulimina pupula*, sp. n., *ovata*, d'Orb., var., *aperta*, sp. n., and *propinqua*, sp. n. Of these *B. pupula* (fig. 13) is a *short* representative of our fig. 19, which latter is intermediate to *B. aperta* and *propinqua*.

*Occurrence.*—The figured specimen is from the Coralline Crag at Sudbourne Hall, zone **d**.

2. Bulimina aculeata, *d'Orbigny*, 1826. Plate III, figs. 1, 2.

Part I, 1866, Appendix II, Table, No. 67.

Polymorpha *pineiformia*, *Soldani*, 1791. Testaceogr., vol. i, part 2, p. 118, pl. cxxvii, fig. I and K (?); pl. cxxx, fig. vv; and pl. cxxxi, fig. xx (?).

BULIMINA ACULEATA, *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 269, No. 7.
— TRILOBATA, *Idem*. Ibid., p. 269, No. 6.
— PATAGONICA, *d'Orb.*, 1839. Foram. Amér. Mérid., p. 50, pl. i, figs. 8, 9.
TEXTULARIA ECHINATA, *d'Orb.*, 1826. Ann. Sci. Nat., vol. vii, p. 263, No. 24.
BULIMINA ACULEATA, *Reuss*, 1850. Denk. Ak. Wien, vol. i, p. 374, pl. xlvii, fig. 13.
— PUPOIDES, var. SPINULOSA, *Williamson*, 1858. Recent Foram. Great Brit., p. 62, pl. v, fig. 128.
— ACULEATA, *Jones and Parker*, 1860. Q. J. G. S., vol. xvi, p. 303.
— SPINOSA, *Seguenza*, 1862. Atti Acc. Gisen., ser ii, vol. xviii, p. 107, pl. i, figs. 8, 8 *a*.
— PRESLI, var. ACULEATA, *P. and J.*, 1862. Introd. Foram., Appendix p. 311.
— — — 1865. Phil. Trans., vol. clv, p. 373, pl. xvii figs. 68, 69.
— ACULEATA, *J., P., and B*, 1866. Monogr. Foram. Crag, Appendix II, pl. iii, figs. 1, 2.
— — *Reuss*, 1867. Sitzungsb. Akad. Wiss. Wien, vol. lv, p. 95.
— — *Sars*, 1868. Vidensk-Selsk Forhandl. for 1868, p. 249.
— — *Parker, Jones, and Brady*, 1871. A. M. N. H., ser. iv, vol. viii, p. 172, pl. cxi, figs. 126—128.
— — *Siddall*, 1879. Catal. Brit. Rec. For., p. 8.
— — *Brady*, 1884. Report 'Challenger,' p. 406, pl. li, figs. 7—9.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 220, pl. xliii, fig. 8.
— — *Egger*, 1893. Abh. k. Bay. Ak. Wiss., vol. xviii, pt. ii, p. 287, pl. viii, figs. 72 and 78.

*Characters.*—This is an ovate (or rather obovate) *Bulimina*, allied to *B. affinis* and *pupoides*, d'Orb., but ornamented with exogenous shell-growth in the form of prickles attached either to the earlier chambers only, or to the edges and sides of the same in the aftergrowth. The ornament varies considerably in amount. In our fig. 1 in Plate III it appears to be scanty, or it may have been worn off. Williamson's *B. spinulosa*, and the bizarre Soldanian figures associated with *B. aculeata* in the 'Ann. Mag. Nat. Hist.,' 1871 (see above), may be taken for extreme examples.

*Occurrence.*—*Bulimina aculeata* has a very wide geographical range, but affects more especially the deeper waters. It has been found as far north as the north coast of Norway, through the temperate and tropical seas; and as far south as the Antarctic Ice Barrier. Its bathymetrical range extends from 75 to 2740 fathoms.

Its earliest recorded geological occurrence appears to be in the Miocene of Vienna. It has also been found in the Pliocene of Italy, Garrucha (South Spain), and St. Erth. So far as the Crag is concerned, we have nothing to add to the record from the Upper Crag of Southwold given in the First Part of the Monograph.

3. Bulimina marginata, *d'Orbigny*, 1826. Plate III, figs. 5 and 6.

Part I, 1866, Appendix II, Table, No. 68.

Bulimina marginata, *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 269, No. 4, pl. xii, figs. 10—12.
— pulchella, *d'Orb.*, 1839. Foram. Amér. Mérid., p. 50, pl. i, figs. 6, 7 (an elongate form).
— acanthia, *Costa*, 1856. Atti Acc. Pont., vol. vii, p. 335, pl. xiii, figs. 35, 36.
— elegans, *Idem*. Ibid., p. 334.
Cucurbitina cruciata, *Idem*. Ibid., p. 336, pl. xviii, fig. 7.
Bulimina marginata, *Parker and Jones*, 1857. A. M. N. H., ser. 2, vol. xix, p. 296, pl. xi, figs. 39 and 40.
— pupoides, var. marginata, *Williamson*, 1858. Rec. For. Gt. Brit., p. 62, pl. v, figs. 126, 127.
— Preslii, var. marginata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 372, pl. xv, fig. 10; pl. xvii, fig. 70.
— — — *Sars*, 1865. Foss. Dyr. Qvart., pp. 66, 68.
— pupoides, var. marginata, *Alcock*, 1865. Proc. Lit. Phil. Soc. Manch., vol. iv, p. 206.
— marginata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, Appendix II, pl. iii, figs. 5, 6.
— — *G. M. Dawson*, 1870. Canad. Nat., n. s., vol. v, p. 179.
— — *Terrigi*, 1880. Atti Accad. Pont. Nuovi Lincei, vol. xxiii, p. 194, pl. ii, figs. 35, 36.
— — *Brady*, 1884. Report 'Challenger,' p. 405, pl. li, figs. 3—5.
— — *Brady, Parker, and Jones*, 1888. Tr. Zool. Soc., vol. xii, part 7, p. 220, pl. xliii, figs. 7 & 10.
— — *Egger*, 1893. Abh. k. Bay. Ak. Wiss., vol. xviii, pt. 2, p. 287, pl. viii, figs. 69, 70.
— — *Goës*, 1894. K. Sv. V.-Ak. Handl., vol. xxv, No. 9, p. 46, pl. ix, figs. 439—444.

*Characters*.—More or less ovate (obovate) and tapering; the chambers extend backwards with a free edge (marginate), which is crenate, serrate, or prickly.

*Occurrence*.—*Bulimina marginata* has a very wide geographical and bathymetrical range. In the Distribution Tables appended to the 'Challenger' Report it is recorded from the South and North Pacific, 345—675 fathoms; between Prince-Edward Island and Kerguelen, 1375 fathoms; off the coast of New Guinea, 1070 fath.; off the west coast of Patagonia, 40—175 fath., W. Australia ('Gazelle').

The earliest recorded geological occurrence of this species appears to be in the Miocene of Italy. It has also been found in the Pliocene of St. Erth, and in the Pleistocene of Norway, Scotland, and Ireland. So far as the Crag is concerned,

we have nothing to add to the record given in the First Part of the Monograph, namely, from the Crag with *Cyprina* ( = *Arctica*) *Islandica*.

### *Genus* 2.—Virgulina, *d'Orbigny*, 1826.

*Brady, Report 'Challenger,'* 1884, *pp.* 68 *and* 413.

Virgulina, *d'Orbigny, Römer, Bronn, Reuss, Czjzek, Egger, Parker and Jones, Karrer, Brady, M. Sars, von Hantken, Schultze, Robertson, Geinitz, Terrigi, Andreae, Malagoli, Basset, Seguenza, Pictet, Goës, Schwager.*
Bulimina, *Bailey, Parker and Jones, Williamson.*
Polymorphina, *Costa.*

In Ehrenberg's 'Mikrogeologie' several species of *Virgulina* are referred to under the names of *Grammobotrys*, *Grammostomum*, *Heterostomum*, *Pleurites*, *Sphæroidina*, *Strophoconus*, *Textilaria*, and *Polymorphina*. See 'Annals Mag. Nat. Hist.,' ser. 4, vols. ix and x, 1872, "The Species figured by Ehrenberg."

*General Characters.*—An elongate, subcompressed, Buliminoid shell, asymmetrically biserial.

1. Virgulina Schreibersiana, *Czjzek*, 1848. Var. obesa, nov. Plate VI, fig. 20.

Virgulina Schreibersiana, *Czizek*, 1848. Haidingers Naturw. Abhandl., vol. ii, p. 147, pl. xiii, figs. 18—21 ("*Schreibersii*" on the plate).
Polymorphina longissima, *Costa*, 1856. Atti Accad. Pont., vol. vii, pl. xiii, figs. 22, 23.
— appula, *Idem.* Ibid., p. 286, pl. xviii, fig. 17.
Virgulina Schreibersana, *Egger*, 1857. Neues Jahrb. für 1857, p. 295, pl. xii, figs. 12—14.
Bulimina pupoides, var. compressa, *Williamson*, 1858. Rec. Foram. Gt. Brit., p. 63, pl. v, fig. 131.
Virgulina Schreibersii, *Parker and Jones*, 1862. Introd. Foram., Appendix, p. 311.
Bulimina Presli, var. (Virgulina) Schreibersii, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 375, pl. vx, fig. 18; pl. xvii, figs. 72, 73.
Virgulina Schreibersiana, *Reuss*, 1867. Sitzungsb. Akad. Wien, vol. lv, part 1, p. 96, pl. iv, figs. 4 *a*, *b*, 5.
— Schreibersi, *Hantken*, 1875. Mitth. Jahrb. k. Ung. Geol. Anstalt, vol. iv, p. 63, pl. vii, fig. 15.

VIRGULINA SCHREIBERSII, *Schwager*, 1877. Bollet. R. Com. Geol. Ital., vol. viii, p. 25, pl. o, fig. 39.

— SCHREIBERSIANA, *Brady*, 1884. Report 'Challenger,' p. 414, pl. lii, figs. 1—3.

— SCHREIBERSI, *Andreae*, 1884. Abhandl. geol. Specialk. Elsass-Lothr., vol. ii, pt. 3, p. 213, pl. ix, figs. 8, 9.

— SCHREIBERSII, *Malagoli*, 1887. Atti Soc. Nat. Modena (Rend.), ser. 3, vol. iii, p. 108, pl. i, fig. 5.

— SCHREIBERSIANA, *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 220.

— — *Egger*, 1893. Abh. k. Bay. Ak. Wiss., vol, xviii, part 2, p. 290, pl. viii, figs. 93 & 95.

— — *Goës*, 1894. K. Sv. Vet.-Akad. Handl., vol. xxv, No. 9, p. 48, pl. ix, figs. 459, 461—472.

*Characters.*—This specimen has a rather rough surface, apparently from the wearing away or the decay of the shell; the smaller end in particular may have become rounded by the loss of the sharp apex common in the species. Compared with Czjzek's figure 21, this individual bears a strong likeness to the type in the arrangement of chambers, although it differs in being thick with a subovoid outline. Its long inflated chambers, variously arranged, parallel with the axis of the shell or nearly so, are characteristically typical.[1]

The elongate forms of *Virgulina Schreibersiana* have been abundantly illustrated by the authors above referred to, but the shorter and thicker individuals have been rarely figured. Dr. A. Goës's fig. 464 is one of the few of this kind.

*Occurrence.*—*Virgulina Schreibersiana* is one of the most common of the Foraminifera, and is found in nearly all seas, and at all depths down to 3000 fathoms. It is common in the high latitudes of the Northern Hemisphere; but it has not apparently been recorded from correspondingly high latitudes of the Southern Ocean.

Its earliest recorded occurrences in the fossil condition are in the Chalk of Swanscombe and Taplow. We have not noticed its occurrence in the Eocene, but it has been recorded from the Oligocene of Elsass, from the Miocene of Italy and Vienna, and from the Pliocene of Italy and St. Erth.

The variety *obesa*, figured Pl. VI, fig. 20, is from the Coralline Crag of Sudbourne Hall, zone **d**.

[1] 'Annals Mag. Nat. Hist.,' ser. 4, vol. x, 1872, p. 186.

*Genus* 3.—Bolivina, *d'Orbigny*, 1839.

*Brady, Report 'Challenger,' pp.* 68 *and* 416.

Bolivina, *d'Orbigny, Reuss, Egger, Parker and Jones, Karrer, Carpenter, Brady, Schwager, von Hantken, Robertson, Vanden Broeck, Wright, Mariani, Malagoli, Berthelin, Terrigi, Möbius, Bronn, Costa, Egger, Andreae, Seguenza, Marsson, Toutkowsky, Zittel, Woodward and Thomas, Goës, Millett, Dervieux, de Amicis, Guppy, &c.*

Grammostomum, Strophoconus, Textilaria, Polymorphina, Proroporus, *Ehrenberg.* Brizalina, *Costa.*

*General Characters.*—Weak compressed modifications of *Bulimina*, distinctly biserial like *Textilaria*, but having the oblique unsymmetrical aperture of *Bulimina*.

1. Bolivina punctata, *d'Orbigny*, 1839. Plate III, figs. 3, 4.

Part I, 1866, Appendix II, Table, No. 69.

Bolivina punctata, *d'Orbigny*, 1839. For. Am. Mér., p. 63, pl. viii, figs. 10—12.
— antiqua, *Idem*, 1846. For. Foss. Vienne, p. 240, pl. xiv, figs. 11—13.
Grammostomum polystigma, *Ehrenberg*, 1854. Mikrogeologie, pl. xix, fig. 84.
— caloglossa, *Idem*, 1854. Ibid., pl. xxv, figs. 17, 18.
— polytheca, *Idem*, 1854. Ibid., pl. xxv, figs. 19, 20.
Bolivina antiqua, *Egger*, 1857. Neues Jahrb. für Jahrg., 1857, p. 294, pl. viii, figs. 22—26.
— punctulata, *Parker and Jones*, 1860. Quart. Journ. Geol. Soc., vol. xvi, p. 302, No. 60 (Table).
— antiqua, *Karrer*, 1861. Sitzungsb. k. Ak. Wiss. Wien, vol. xlvi, p. 457.
— catanensis, *Seguenza*, 1862. Rhizopod. Foss. Pleist. Catania, p. 113, pl. ii, figs. 3, 3 *a*, 3 *b*.
— punctata, *Carpenter*, 1862. Introd. Foram., p. 197.
— — *Brady*, 1864. Tr. Linn. Soc., vol. xxiv, p. 468, pl. xlviii, fig. 9.
— — *Idem*, 1865. Nat. Hist. Trans. North. and Durham, vol. i, p. 103, pl. xii, fig. 8.
Bulimina Presli, var. (Bolivina) punctata, *P. and J.*, 1865. Phil. Trans., vol. clv, p. 376, pl. xvii, fig. 74.
Bolivina punctata, *J., P., and B.*, 1866. Monogr. For. Crag, Appendix II, Table, No. 69, pl. iii, figs. 3, 4.
— antiqua, *Reuss*, 1866. Denkschr. k. Ak. Wiss. Wien, vol. xxv, p. 41.
— punctata, *Brady*, 1870. Ann. Nat. Hist., ser. 4, vol. vi, p. 302.
— elongata, *Hantken*, 1875. Mitth. Jahrb. Ung. Geol. Anstalt, vol. iv, p. 65, pl. vii, fig. 14.
punctulata, *Schwager*, 1877. Boll. R. Com. Geol. Ital., vol. viii, p. 26, pl. o, fig. 63.
— antiqua, *Terrigi*, 1880. Atti Accad. Pont. Nuov. Lincei, Ann. xxxiii, p. 196, pl. ii, fig. 40.

Bulimina (Bolivina) punctata, *Goës*, 1882. K. Sv. V.-Ak. Handl., vol. xix, No. 4, p. 69, pl. iv. figs. 114—126.
Bolivina punctata, *Möbius*, 1880. Meeresfauna Mauritius, p. 94, pl. ix, figs. 9, 10
— — *Brady*, 1884. Report 'Challenger,' p. 417, pl. lii, figs. 18, 19.
Textularia inflata, *Andreae*, 1884. Abhandl. Geol. Spec.-Karti Elsass-Loth., vol. ii, Heft. 3, p. 306, pl. vi, figs. 6, 6 *a*, *b*.
Bolivina Melettica, *Andreae*, 1884. Ibid., pp. 527 and 262, pl. xi, fig. 5.
— punctata, *Woodward and Thomas*, 1885. Thirteenth Ann. Report Minnesota, p. 169, pl. iii, fig. 12.
— — *Sherborn and Chapman*, 1886. Journ. Roy. Microsc. Soc., ser. 2, vol. vi, p. 743, pl. xiv, figs. 10 *a*, *b*.
— — *Malagoli*, 1889. Boll. Soc. Geol. Ital., vol. vii, p. 375, pl. xiv, figs. 1—4.
— — *Fornasini*, 1889. Rhizopod. Plioc. Bologna, pl. o, fig. 5.
— — *Terrigi*, 1889. Atti Accad. Linc., ser. 4, vol. vi, p. 110, pl. v, fig. 8.
— — *Idem*, 1891. Mem. R. Com. Geol. Ital., vol. iv, part 1, p. 74, pl. i, figs. 26, 27.
— — *De Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, p. 351.
— — *Egger*, 1893. Abh. k. Bay. Ak.-Wiss., vol. xviii, part 2, p. 298, pl. viii, figs. 1—3.
— — *Goës*, 1894. K. Sv. V.-Ak. Handl., vol. xxv, No. 9, p. 49, pl. ix, figs. 475—480.

*Characters.*—Shell straight or slightly curved; chambers very numerous, narrow, arcuate, neat. Foramina usually conspicuous.

There is a considerable range of variation, in minor particulars, amongst the feeble biserial forms of *Bulimina* included under the sub-type *Bolivina*. We can, however, find no single character in *B. antiqua* as figured by d'Orbigny, and subsequently by Egger, which can be said to form valid ground for even varietal separation from his previously described recent species *B. punctata*.

*Occurrence.*—*Bolivina punctata* is shown in the 'Challenger' and 'Gazelle' Reports to be a cosmopolitan species. Its bathymetrical range extends from 2 to 2740 fathoms. As a fossil it is of very common occurrence. It has been recorded from the phosphatic chalk of Taplow, the Eocene London Clay, the Oligocene of Elsass, the Miocene of Malaga, Italy, Vienna, and Muddy Creek (Victoria), and from the Pliocene of Italy, Garrucha (South Spain), and St. Erth. In the Coralline Crag it has been found in every zone examined.

2. Bolivina Ænariensis (*Costa*), 1856. Plate VI, fig. 21.

Brizalina Ænariensis, *Costa*, 1856. Atti Accad. Pont., vol. vii, p. 297, pl. xv, figs. 1 *a*, A, B.

BOLIVINA ÆNARIENSIS, *Brady*, 1882. Proceed. Roy. Soc. Edinb., vol. xi, p. 711, Table.
— — *Idem*, 1884. Report 'Challenger,' p. 423, pl. liii, figs. 10, 11.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 221, pl. xliii, figs. 2, 4, 5.
— — *Malagoli*, 1889. Boll. Soc. Geol. Ital., vol. vii, p. 377, pl. xiv, figs. 11, 12.

*Characters.*—Small, compressed, elongate, lanceolate in outline, with numerous regular, Textilariform, curved chambers. There are no external ornaments, such as the linear costulæ, which Brady noticed to be sometimes absent, and which are wanting in a specimen from the Abrohlos, 'Trans. Zool. Soc.,' 1888, pl. xliii, fig. 5. Individuals vary also in their relative width and length, as is shown in the same pl. xliii.

*Occurrence.*—*Bolivina Ænariensis* has been most commonly met with in dredgings from the North Atlantic, and is everywhere confined apparently to the littoral shallow zones. The greatest depth from which specimens have been recorded is 1630 fathoms in the Faroe Channel. Our earliest record of the species in a fossil condition is from the Miocene of Italy, and of Muddy Creek, Victoria. It has also been recorded from the Pliocene of Italy; and we have specimens in our own collections from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag we have specimens from every zone examined. The figured specimen is from Sudbourne Hall, zone **d**.

## *Sub-family* 3.—CASSIDULININÆ.

*Brady, Report 'Challenger,'* 1884, *pp.* 69, 427.

*General Characters.*—Test consisting of a Textilarioid series of alternating segments, more or less coiled on itself.

### *Genus* 1.—CASSIDULINA, *d'Orbigny*, 1826.

CASSIDULINA, *d'Orbigny, Sander-Rang, Menke, Bronn, Reuss, Schultze, Egger, Parker and Jones, Williamson, Carpenter, Brady, M. Sars, Parfitt, Alcock, Winther, Schulze, G. M. Dawson, von Hantken, Seguenza, Wright, Norman, Bütschli, Terrigi, Franzenau, Hartwig, Greene, Zittel, Schwager, Nicholson, Schlumberger, Quenstedt, Basset, Karrer, Andreae, Sherborn, Chapman, Guppy, &c.*

GLOBIGERINA, *d'Orbigny*.
BURSEOLINA, *Seguenza*.
STROPHOCONUS and MEGATHYRA, *Ehrenberg*.

*General Characters*.—Test lenticular, oblong or ovate, biserial, folded on its long axis, and coiled more or less completely on itself; rarely dimorphous. Chambers elongate, curved; the two series alternating, and the principal part of the exposed chambers turned towards opposite sides of the shell. Aperture a curved slit extending to the middle of the septal plane.

1. CASSIDULINA LÆVIGATA, *d'Orbigny*, 1826. Plate IV, figs. 15 *a*, *b*.

Part I, 1866, Appendix II, Table, No. 70.

CASSIDULINA LÆVIGATA, *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 282, No. 1, pl. xv [vi by error in the text], figs. 4 and 5; Modèle, No. 41.
— PULCHELLA, *d'Orbigny*, 1839. Foram. Amér. Mérid., p. 57, pl. viii, figs. 1—3.
— LÆVIGATA, *Cuvier*, 1846? Regne Anim. (1836–46), vol. ix, p. 33, pl. xv, fig. 3.
— — *Reuss*, 1846. In Geinitz's Grundr. Verstein., p. 660, pl. xxiv, fig. 42.
— PUNCTATA, *Reuss*, 1849. Denksch. k. Akad. Wiss. Wien, vol. i, p. 376, pl. xlviii, figs. 4 *a*, *b*.
— LÆVIGATA, *Parker and Jones*, 1857. Ann. Mag. Nat. Hist., ser. 2, vol. xix, p. 295, pl. xi, figs. 17 and 18.
— — *Williamson*, 1858. Rec. Brit. Foram., p. 68, pl. vi, figs. 141 and 142.
— — *Morris and Quekett*, 1860. Catal. Hunterian Mus., p. 92, A. 34.
— SICULA, *Seguenza*, 1862. Atti Accad. Gioenia, ser. 2, vol. xviii, p. 111, pl. i, figs. 7, 7 *a*.
— LÆVIGATA, *Sars*, 1864. Foss. Dyrelevn. Qvarterper., pp. 62, 68, &c.
— — *Parker, Jones, and Brady*, 1865. Ann. Mag. Nat. Hist., ser. 3, vol. xvi, p. 25, pl. ii, fig. 67.
— — *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 377, pl. xv, figs. 1—4; pl. xvii, figs. 64 *a—c*.
— — *Brady*, 1865. Nat. Hist. Trans. Northumb. and Durham, vol. i, p. 104, No. 1.
— — *Parker, Jones, and Brady*, 1866. Monogr. Foram. Crag, Appendix II, Table, No. 76, pl. iv, figs. 15 *a*, *b*.
— — *Hartwig*, 1866. The Sea, 3rd edit., p. 381, fig. *e*.
— — *Sars*, 1868. Videnskab-Selsk. Forhandl. for 1868, p. 249.
— — *G. M. Dawson*, 1870. Canad. Nat., n. s., vol. v, p. 179.

| | | |
|---|---|---|
| Cassidulina lævigata, | *Greene*, 1871. | Manual Protozoa, p. 15, fig. 3 *e*. |
| — | — *Zittel*, 1876. | Handb. Palæont., part 1, p. 91, fig. 29. |
| — | — *Figuier*, 1873. | Ocean World, p. 84. fig. 21. |
| — | — *Schwager*, 1877. | Boll. R. Com. Geol. Ital., vol. viii, p. 26, pl. o, fig. 67. |
| — | — *Nicholson*, 1879. | Manual Palæont., vol. i, p. 116, fig. 18 *m*. |
| — | — *Terrigi*, 1880. | Atti Accad. Pont. N. Lincei, vol. xxxiii, p. 199, pl. ii, fig. 47. |
| — | — *Schlumberger*, 1882. | Feuille Jeun. Nat., part 1, fig. 15. |
| — | — *Jones*, 1884. | In Microgr. Dict., 4th edit., p. 136, pl. xxiii, figs. 45 *a*, *b*. |
| — | — *Brady*, 1884. | Report 'Challenger,' p. 428, pl. liv, figs. 1—3. |
| — | — *Quenstedt*, 1885. | Handb. Petref., 3rd edit., part 5, p. 1059, pl. lxxxvi, fig. 59. |
| — | — *Basset*, 1885. | Ann. Soc. Sci. Charente-Inf., p. 162, fig. 41. |
| — | — *Brady, Parker, and Jones*, 1888. | Trans. Zool. Soc., vol. xii, part 7, p. 221, pl. xliii, fig. 11. |
| — | — *Terrigi*, 1889. | Mem. R. Accad. Lincei, ser. 4, vol. vi, p. 111, pl. v, fig. 9. |
| — | — *Egger*, 1893. | Abhandl. k. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 276, 302, pl. vii, figs. 47, 48, 54—56. |
| — | — *Goës*, 1894. | K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 43, pl. viii, figs. 418—420. |

*Characters.*—Nearly circular, biconvex, with thin edge, sometimes partially keeled; long, curved, very slightly inflated chambers.

Authors seem well agreed as to the characters of the typical *Cassidulina lævigata*. *C. punctata* of Reuss does not appear to present any peculiarities necessitating varietal separation; and the number and size of the pseudopodial apertures vary in different individuals of almost every species of hyaline Foraminifera, and, indeed, alter with the age of the shell; and it is on these foramina rather than any more important data that Prof. Reuss has depended for its diagnosis. For the same reasons the *C. sicula* of Seguenza is included. Professor Williamson was probably right in regarding *C. pulchella* of d'Orbigny as a representative of modifications having no morphological significance unless present to a much greater degree than shown in the figures of the South-American specimen.

*Occurrence.*—*Cassidulina lævigata* is most frequently found in the temperate, arctic, and antarctic seas; but it is not confined to those latitudes. Its bathymetrical range extends from 60 to 1675 fathoms.

Its earliest recorded appearance as a fossil is from the London Clay of the Isle

of Wight (Brady). It has also been met with in the Miocene of Vienna, and of Muddy Creek, Victoria; in the Pliocene of Italy and St. Erth; and in the Pleistocene of Norway, Ireland, and Ischia. We have also in our own collections numerous specimens from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag we have specimens from nearly every zone examined.

2. Cassidulina crassa, *d'Orbigny*, 1840. Plate IV, fig. 16 (var. *oblonga*); woodcut fig. 18 (*crassa*).

Part I, 1866, Appendix II, Table, Nos. 71 and 72.

Polymorpha tuberosa et globulifera, *Soldani*, 1791. Testaceographia, vol. i, pt. 2, p. 117, pl. cxxiii, fig. k.

Globigerina elongata, *d'Orbigny*, 1826. Ann. Sci. Nat., vol. vii, p. 277, No. 4.

Cassidulina crassa, *d'Orbigny*, 1840. Foram. Amér. Mérid., p. 56, pl. vii, figs. 18—20.

— — *Idem*, 1846. For. Foss. Vien., p. 213, pl. xxi, figs. 42, 43.

— oblonga, *Reuss*, 1850. Denkschr. k. Ak. Wiss. Wien, vol. i, p. 376, pl. xlviii, figs. 5, 6.

— — *Egger*, 1857. Neues Jahrb. für Jahrg. 1857, p. 295, pl. xi, figs. 1—3.

— lævigata (in part), *Parker and Jones*, 1857. Ann. Nat. Hist., ser. 2, vol. xix, p. 295, pl. xi, fig. 18.

— obtusa, *Williamson*, 1858. Rec. For. Gt. Brit., p. 69, pl. vi, figs. 143, 144.

— crassa, *Bronn*, 1859. Klass. Ordn. Thier-Reichs, part 1, p. 69, fig. 6.

— — *Jones and Parker*, 1860. Quart. Journ. Geol. Soc., vol. xvi, p. 302, No. 152, Table.

— oblonga, *Iidem*, 1860. Ibid., p. 302, No. 153, Table.

— crassa, *Carpenter*, 1862. Introd. Foram., p. 198.

— lævigata, var. crassa, *Parker and Jones*, 1862. In Carpenter's Introd., App., p. 311.

— — — *Iidem*, 1865. Phil. Trans., vol. clv, p. 377, pl. xv, figs. 5—7; pl. xvii, fig. 64 *d*.

— obtusa, *Alcock*, 1865. Proc. Lit. and Phil. Soc. Manchester, vol. iv, p. 206.

— crassa, *Reuss*, 1865. Model, No. 43 (Catal., 1861, No. 81).

— oblonga, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, Appendix II, No. 71, pl. iv, fig. 16.

— crassa, *Iidem*, 1866. Ibid., No. 72.

— — *G. M. Dawson*, 1870. Canad. Nat., n. s., vol. v, p. 179.

— oblonga, *Parker, Jones, and Brady*, 1871. Ann. Nat. Hist., ser. 4, vol. viii, p. 175, pl. xi, fig. 129.

CASSIDULINA CRASSA, *Bütschli*, 1880. In Bronn's Klass. Thier-Reichs, p. 205, pl. viii, fig. 6.

— — *Terrigi*, 1883. Atti Accad. Pont. N. Lincei, vol. xxxv, p. 192, pl. iii, fig. 34.

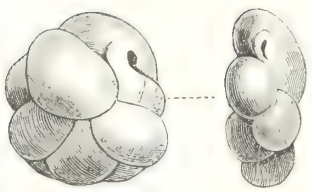
— — *Brady*, 1884. Report 'Challenger,' p. 429, pl. liv, figs. 4, 5.

— — *Andreae*, 1884. Abhandl. geol. Specialk. Elsass-Lothringen, vol. ii, part 3, p. 235, pl. x, figs. 31, 32.

— — *Egger*, 1893. Abhandl. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 276, 303, pl. vii, figs. 35, 36.

— OBLONGA, *Idem*. Ibid., figs. 33, 34.

— CRASSA, *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 43, pl. viii, figs. 421, 422.



FIGS. 18 *a*, *b*. *Cassidulina crassa*, d'Orb. × 24. From the 'Phil. Trans.,' vol. clv, pl. xv, figs. 6 and 7.

*Characters*.—Shell ovate-oblong, biconvex, but more or less compressed; margin obtuse or rounded. It is smaller and relatively thicker than *Cassidulina lævigata*, and the segments are fewer and comparatively short and inflated.

*C. crassa*, var. *oblonga* (Pl. IV, fig. 16), is an asymmetrical varietal modification usually smaller than the type; it indicates a possible line of divergence, but not of much zoological importance. Dr. Egger (whose work in 1893 on the Foraminifera collected by the 'Gazelle' is referred to above) does not agree with this amalgamation of the Cassiduline varieties (p. 303).

*Occurrence*.—*Cassidulina crassa* has a world-wide range, and has been recorded from depths ranging from 40 fathoms in the North Pacific down to 2760 fathoms in the North Atlantic.

The earliest recorded appearance of the species in a fossil condition is in the Miocene of Vienna. It has been found in the Pliocene of Italy and St. Erth; and we have in our own Collection specimens from the Casterlian and Scaldisian of Antwerp. So far as the Crag is concerned, we have nothing to add to the record given in the First Part of the Monograph.

*Cassidulina oblonga*.—This variety appears only to have been met with in a fossil condition. The formations in which it has been found are the Oligocene of Elsass, the Miocene of Vienna, and the Pliocene of Garrucha (South Spain) and St. Erth. So far as the Crag is concerned, we have nothing to add to the record in the First Part of the Monograph.

### *Family* 3.—LAGENIDÆ.

*Brady, Report 'Challenger,' 1884, pp. 69 and 439.*

*General Characters.*—Test finely perforated, either monothalamous or polythalamous; in the latter case in a straight, curved, spiral, or alternating series of segments. Aperture simple or radiate, terminal. No canal-system.

### *Sub-family* 1.—LAGENINÆ.

*Brady, Report 'Challenger,' 1884, pp. 69 and 440.*

*General Characters.*—Test monothalamous; ecto- or ento-solenian.

### *Genus* 1.—LAGENA, *Walker and Jacob*,[1] 1784.

*Brady, Report 'Challenger,' 1884, pp. 69 and 440.*

Part I, 1866, page 28.

*Additional Synonyms:*

Orthocerata globularia, &c., Flosculi, Polymorpha, Sphærulæ siphunculatæ, hispidæ, &c., Globuli zoophytici, Ossicula Madreporaria, Testæ ovales, oviformes, glandiformes, fusiformes, &c., *Soldani*.[2]

HOLOCOCCUS? *Ehrenberg*.

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[1] The authorship of the species usually ascribed to "Walker and Jacob" is considered at length in a note at page 28 of Part I, 1866.

[2] In the 'Bolletino Soc. Geol. Italiana,' vol. v, 1886, pp. 132—254, Signor C. Fornasini carefully and clearly indicated to what modern genera and species of Foraminifera those figured by Soldani in his great work, 'Testaceographia,' &c., 1779—1798, have been with some probability assigned. Of the *Lagenæ* the following are recognised:

Lagena sulcata, *W. and J.* Pages 150, 209, 213, and 225.
— melo, *d'Orb.* Page 194.
— squamosa, *Montagu.* Page 209.
— globosa, *Montagu.* Page 226.
— lævis, *Montagu.* Pages 229, 230.
— gracillima, *Seguenza.* Page 236.
— hispida, *Reuss.* Pages 236, 237.

Amygdalites, *Costa.*
After Oolina add *Ehrenberg, Diesing, Czjzek, Karrer, Kübler and Zwingli.*
Ovolina, *Terquem.*
After Ovulina add *Schafhäutl.*
Ovulida? *Folin.*
After Lagena add *Harvey and Bailey, Gümbel, Stache, Karrer, Czjzek, Schwager, von Hantken, F. W. O. R. Jones, Kübler and Zwingli, Terquem and Berthelin, Fornasini, Bütschli, Fischer, Alcock, Sherborn and Chapman, Haeusler, Mariani, Balkwill and Millett, Wright, Deecke, Mackie, Seguenza, Vine, A. Agassiz, Gruber, Dunikowski, Tate and Blake, Brown, von Schlicht, Terrigi, Toutkowsky, Fric, Green, Prestwich, Morris, Malagoli, Kaufmann, Marsson, Schlumberger, Quenstedt, Steinmann, Gosse, Hartwig, Greene, Möbius, Rzehak, Dawson, Nicholson, Toll, Stache, Siddall, Cooke, Andreae, Wallich, Wood, Chimmo, Folin, Neumayr, Egger, Goës, Guppy, Millett, and others.*
After Lagenula add *Zborzewski.*
Lagenulina, *Terquem.*
After Entosolenia add *Möbius, Reuss, Dawson, Cooke, Chimmo, Schulze, Gosse, Parker and Jones, Schlumberger, Alcock.*
After Fissurina add *Pictet, Franzenau, Terquem, Karrer, Schwager, Bornemann, von Schlicht.*
Cenchridium, *Ehrenberg, Zwingli and Kübler.*
Capitellina, *Marsson.*

*General Characters.*—Test consisting of a single chamber, globose, variously compressed, or tubular, with one terminal aperture (rarely two); aperture round or slit-like, trifid or stellate; level with the surface, or produced (ectosolenian), or continued inwards (entosolenian). See Report, 'Challenger,' p. 441, figs. 11 *a*—*m*. Surface smooth or ornamented.

The species and sub-species of *Lagena* will be here described according to the systematic order adopted in the Report of the 'Challenger,' &c., pp. 440 *et seq.*

Although all the known forms of *Lagena* may be *biologically* referred to one species (so numerous and perfect are the gradations from one variety to another), yet they may be divided, as a "generic series, into sections grouped round a few subtypical forms," most of which have their many varieties and sub-varieties. These are set out in a large scheme or classified list in the Report 'Challenger,' &c., pp. 444—449, and the following Table gives the result in a condensed form.

*Table of the Arrangement of the* Lagenæ. After Dr. H. B. Brady's Scheme, 1884.

| *Form.* | *Surface.* | *Sub-types or Species.* |
|---|---|---|
| I. Round in transverse section ..... | 1. Smooth | *L. globosa.* |
| | | *L. lævis.* |
| | 2. Rough. | *L. aspera.* |
| | 3. Prickled. | *L. hispida.* |
| | 4. Striate. | *L. striata.* |
| | 5. Costate. | *L. sulcata.* |
| | 6. Partly costate. | *L. semistriata.* |
| | 7. Costate and perforate. | *L. striato-punctata.* |
| | 8. Reticulate and perforate. | *L. Hertwigiana.* |
| | 9. Reticulate. | *L. squamosa.* |
| II. Compressed on two or more sides..... | 1. Angle-edged. | *L. lævigata.* |
| | 2. Keeled. | *L. marginata.* |
| | 3. Bi- or tri-carinate. | *L. Orbignyana.* |

1. Lagena globosa (*Montagu*), 1803. Plate I, fig. 32.

Part I, 1866, p. 32; and Appendix I, Table, No. 34, Appendix II, No. 24.

*Additional Synonyms :*[1]

Ossicula *Madreporaria*, *Soldani*, 1796. Testaceographia, vol. i, part 3, p. 245, pl. clxxii, figs. B, C, D, E ?

Lagena globosa, *Brown*, 1844. Illustr. Rec. Conch. Gt. Brit., ed. 2, p. 144, pl. lvi, fig. 37.

— — *Williamson*, 1848. Mem. Lit. Phil. Soc. Manchester, ser. 2, vol. viii, p. 47, pl. [3], fig. 39.

Phialina oviformis, *Costa*, 1856. Atti Accad. Pont. Linc., vol. vii, fasc. 2, p. 123, pl. xi, figs. 8, 9.

"Miliola, Holococcus, Panderi (Trochiliscus, *Pander*)" ? *Ehrenberg*, 1858. Monatsber. k. preuss. Ak. Wiss. für 1858, p. 311; and 1863 ; ibid. for 1862, p. 601, pl. o, fig. 11 (fragment, Devonian). Seguenza's *Fissurina aperta*, Mioc. Mon. Mess., 1862, p. 60, pl. i, fig. 60, is very much like Ehrenberg's figure.

Entosolenia globosa, *J. W. Dawson*, 1859. Canad. Nat., vol. iv, p. 28, figs. 4, 5 (apiculate).

[1] In the fifteenth line of the synonyms at p. 32, Part I, *instead of* Ib. *read* 'Ann. Mag. Nat. Hist.,' ser. 2.

Lagena globosa, *Reuss*, 1863. Sitzungsb. k. Akad. Wiss. Wien, vol. xlvi, p. 318, pl. i, figs. 1—3.

— — *Idem*, 1863. Bull. Acad. Roy. Belg., ser. 2, vol. xv, p. 143, pl. i, figs. 13, 14.

— Aargovensis, *Kübler and Zwingli*, 1866. Neuesjahrsblatt, &c., p. 12, pl. ii, fig. 10, var. *major*; fig. 11, var. *minor*.

— globosa, *Mackie*, 1867. Science Gossip, 1867, p. 129, fig. 105.

Entosolenia globosa, *Cooke*, 1869. Thous. Obj. Microsc., p. 91, pl. ix, fig. 15.

Lagena globosa, *Terquem*, 1870. Mém. Acad. Imp. Metz, vol. li, p. 351, pl. xxv, figs. 24—26.

Cenchridium Aargovense, *Zwingli and Kübler*, 1870. Foram. Schweiz. Jura, p. 13, pl. ii, i, fig. 1 ([var. *major*] long variety), and fig. 2 [var. *minor*].

Lagena Parkinsoni, *Iidem*, 1870. Ibid., p. 17, pl. ii, III, fig. 1.

— minutissima, *Iidem*, 1870. Ibid., pp. 19, 21, pl. ii, IV, fig. 1.

Entosolenia globosa, *G. M. Dawson*, 1870. Canad. Nat., New Ser., vol. v, p. 178.

— — *J. W. Dawson*, 1872. Ibid., vol. vi, p. 254, pl. iii, fig. 2 (part).

Lagenulina globosa, *Terquem*, 1876. Plage Dunkerque, p. 67, pl. vii, figs. 3, 4.

Lagena globosa, *Brady and Robertson*, 1876. Rep. Brit. Assoc. for 1875, p. 189.

Entosolenia globosa, *Schulze*, 1877. Arch. Mikrosk. Anat., vol. xiii, p. 9, pl. ii, figs. 1—3 (structural).

Lagena globosa, *Vine*, 1878. Science Gossip, vol. xiv, p. 52, fig. 26.

— elongata, *Dunikowski*, 1879. Nowe Foram. &c., Kosmos [Lemberg], vol. iv, p. 105, pl. o, fig. 2 (long ovoid).

— maxima, *Idem*, 1879. Ibid., p. 105, fig. 3.

— globosa, *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 2.

— — *Terquem*, 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, p. 26, pl. ix, fig. 7.

Entosolenia globosa, *Jones*, 1883. Microgr. Dict., ed. 4, p. 290, pl. xxiii, figs. 23 *a*, *b*.

Lagena globosa, *Terrigi*, 1883. Atti Accad. Pont. N. Lincei, vol. xxxv, p. 170, pl. ii, fig. 3.

— — *Brady*, 1884. Report 'Challenger,' p. 452, pl. lvi, figs. 1—3.

— — and var., *Sherborn and Chapman*, 1886. Journ. R. Microsc. Soc., ser. 2, vol. vi, p. 744, pl. xiv, figs. 11, 12.

— — *Terquem*, 1886. Mém. Soc. Géol. France, ser. 3, vol. iv, p. 6, pl. i, fig. 6.

— — *Uhlig*, 1886. Jahrb. k. k. Geol. Reichsanst., vol. xxxvi, p. 167, fig. 1.

Entosolenia globosa, *J. W. Dawson*, 1886. Handb. Zool., ed. 3, p. 43, fig. 31.

Lagena globosa, *Haeusler*, 1887. Neues Jahrb. f. Min. for 1887, part 1, pp. 181, 189, pl. iv, figs. 1—18, and pl. v, figs. 19—28 (initial chambers of *Nodosaria radicula*).

— — *Brady*, 1888. Geol. Mag., dec. 3, vol. v, pp. 444, 481, pl. xiii, figs. 1—3.

Lagena globosa, *Terrigi*, 1889. Mem. R. Accad. Lincei, ser. 4, vol. vii, p. 111, pl. v, fig. 10; pl. vi, figs. 4—6.
— — *Mariani*, 1889. B. S. Geol. Ital., vol. vii, p. 285, pl. x, figs. 3, 4.
— — *Frič*, 1889. Arch. Nat. Landesd. Böhmens, vol. vii, p. 110, woodcut 155.
— — *Terrigi*, 1891. Mem. R. Com. Geol. Ital., vol. iv, p. 77, pl. ii, fig. 1.
— — *Meriani*, 1892. Boll. Soc. Geol. Ital., vol. x, p. 725, pl. i, fig. 7.
— — *Idem*, 1893. Ann. Istit. Tecn. Udina, ser. 2, ann. xi, p. 22 (sep. copy), pl. i, fig. 7.
— — *Egger*, 1893. Abhandl. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 320, 323, pl. x, fig. 69.
— — *Chapman*, 1893. Journ. R. Microsc. Soc. for 1893, p. 579, pl. viii, figs. 1 *a*, *b*.
— — *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 77, pl. xiii, fig. 741 (with synonyms).
— — *Chapman*, 1894. Quart. Journ. Geol. Soc., vol. l, p. 705.

*Characters.*—Test globular, subglobular, elliptical, ovoid, or pyriform, smooth; aperture with an entosolenian neck and a variable orifice.

*Occurrence.*—*Lagena globosa* is found in all seas without restriction as to latitude or depth. It is also of wide distribution in a fossil condition. It is recorded from the Upper Silurian (Brady); from the Jurassic of Switzerland; from the Lower Cretaceous (Bargate beds) of Surrey; Gault, Folkestone; Red Chalk, Speeton; Upper Chalk, Taplow, Ireland, and Maestricht; from the Eocene, London Clay; from the Oligocene of Elsass and Pietzpuhl; from the Miocene of Muddy Creek, Victoria; from the Pliocene of St. Erth and Belgium (Casterlian and Scaldisian) and Piedmont; and from the Pleistocene generally. In the Coralline Crag *L. globosa* occurs in nearly all the exposures examined, but it is rare.

2. Lagena apiculata, *Reuss*, 1850. Plate I, fig. 27.

Part I, 1866, p. 44; and Appendix II, Table, No. 33.

*Additional Synonyms:*

Miliola caudata, *Ehrenberg*, 1854. Mikrogeologie, pl. xxix, fig. 46.
Lagena apiculata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 44, pl. i, fig. 27.
Oolina liassica, *K. and Z.*, 1866. Neujahrbl., &c., p. 57, pl. i, fig. 15
Lagena bullæformis, *Schwager*, 1868. Pal. Beitr., vol. i, p. 655, pl. xxxiv, fig. 5.
— Nos. 11—17, 19, 21, 23, *Schlicht*, 1870. Pietzpuhl, pp. 4—6, pls. i, ii.
— vulgaris, var. apiculata, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 50, pl. xix, figs. 3—5.

LAGENA APICULATA, *Terquem*, 1870. Mém. Acad. Imp. Metz, vol. li, p. 350, pl. xxv, figs. 22, 23.
— — *Hantken* [1876], 1881. Mitth. Jahrb. Ungar. Geol. Anst., vol. iv, p. 22, pl. xii, fig. 7 (1876 in Hungary).
— CAUDATA, *Brady and Robertson*, 1876. Rep. Brit. Assoc. for 1875, p. 190.
— MAXIMA, *Dunikowski*, 1879. Kosmos (Lemberg), vol. iv, p. 105, fig. 3.
— APICULATA, *Bütschli*, 1880. Bronn's Klassen, &c., p. 197, pl. vii, fig. 3.
— — *Brady*, 1884. Report 'Challenger,' pp. 444, 453, pl. lvi, figs. 4, 15—18.
— — *Sherborn and Chapman*, 1886. Journ. Roy. Micr. Soc., ser. 2, vol. vi, p. 744, pl. xiv, fig. 14.
— — *Terquem*, 1886. Mém. Soc. Géol. France, ser. 3, vol. iv, p. 6, pl. i, fig. 5.
— — *Haeusler*, 1887. Neues Jahrb. f. Min., &c., for 1887, part 1, p. 182, pl. iv, figs. 19—30; and pl. v, figs. 36, 37.
— — *Terrigi*, 1889. Mem. R. Accad. Lincei, ser. 4, vol. vi, p. 111, pl. v, fig. 11.
— — *Mariani*, 1889. Boll. Soc. Geol. Ital., vol. vii, p. 285, pl. x, fig. 5.
— — *B., S., and B.*, 1890. Journ. R. Micr. Soc., p. 555, pl. ix, figs. 6, 7, 9—11.
— — var. ODONTOSTOMA, *de Amicis*, 1893. Ibid., vol. xii, fasc. 3, p. 352, pl. iii, figs. 9 *a*, *b*.
— — *Egger*, 1893. Abhandl. Bayer. Ak. Wiss., vol. xviii, part 2, pp. 321, 324, pl. x, fig. 8.
— — *Chapman*, 1893. Journ. R. Microsc. Soc. for 1893, p. 581, pl. viii, figs. 2 *a*, *b*, and figs. 3 *a*, *b*. [Elongate and globose forms.]
— — var. EMACIATA, *Idem*, 1893. Ibid., figs. 4 and 7.
— — *Idem*, 1894. Quart. Journ. Geol. Soc., vol. l, p. 705.
— — *Goës*, 1894. K. Sv. Vet.-Akad. Handl., vol. xxv, No. 9, p. 80, pl. xiii, fig. 747.

*Characters.*—Entosolenian and otherwise, also like *L. globosa*, but pointed, instead of round, at the base.

*Occurrence.*—*Lagena apiculata* is a cosmopolitan form, found in all latitudes, and at all depths from the littoral zone to 2750 fathoms. As a fossil it is also very widely distributed. It has been recorded from the Lias; from the Neocomian Beds of Surrey; from the Gault of Folkestone; from the Eocene, London Clay; from the Oligocene of Elsass; from the Miocene of Messina; and from the Pliocene of Italy and St. Erth. In the Coralline Crag it has been met with at Sutton only.

3. Lagena lævis (*Montagu*), 1803. Plate I, fig. 28.

Part I, 1866, p. 33; and Appendix II, Table, No. 25.

*Additional Synonyms:*

Testæ oviformes, glandiformes, fusiformes, &c., *Soldani*, 1798. Testaceographia, &c., vol. ii, pp. 16, 17, pl. iii, figs. *ee*, *ll*, *rr*; and pl. iv, fig. *ss*.

Phialina pyriformis, *Costa*, 1856. Atti Accad. Pont., vol. vii, fasc. 2, p. 123, pl. xi, fig. 6, var. fig. 10.

Lagena lævis, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 33, pl. i, fig. 28.

— — *Mackie*, 1867. Science Gossip for 1867, p. 130, fig. 112.

— [ — var.] antiqua, *Alcock*, 1868. Mem. Lit. Phil. Soc. Manchester, ser. 3, vol. iii, p. 176, pl. iv, fig. 3.

— — *G. M. Dawson*, 1870. Can. Nat., n. s., vol. v, p. 178.

— Nos. 26—29, *Schlicht*, 1870. Pietzpuhl, pp. 6, 7, pl. ii, figs. 3, 7, 8, 11.

— vulgaris, *Terquem*, 1870. Mém. Ac. Imp. Metz, p. 349, pl. xxv, figs. 20, 21.

— Helvetica, *Zwingli and Kübler*, 1870. Foram. Schweiz. Jura, p. 24, pl. iii, fig. 1; and p. 33, pl. iv, Impressathon, fig. 1.

— Badensis, *Iidem*, 1870. Ibid., p. 38, pl. iv, Bed.-Sch., fig. 1.

— vulgaris, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 51, pl. xix, figs. 10, 12, 13.

— — var. bicamerata, *Idem*, 1872. Ibid., p. 65, pl. xix, figs. 60, 61.

— — *Terquem*, 1875. Plage Dunkerque, p. 21, pl. i, fig. 3.

— — *Terquem and Berthelin*, 1875. Mém. Soc. Géol. Fr., ser. 2, vol. x, p. 13, pl. xi, figs. 6 *a*, *b*.

— lævis, *Morris*, 1876. Lect. Geol. Croydon, p. 8, fig. 3 *b*.

— — *Brady and Robertson*, 1876. Brit. Assoc. Rep. for 1875, p. 189.

— — *Terrigi*, 1880. Atti Acc. P. N. Lincei, vol. xxxiii, p. 176, pl. 1, fig. 4.

— — *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 21.

— — *Green*, 1881. Amer. Journ. Microsc., vol. vi, p. 46, pl. o, fig. 1.

— vulgaris, *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, p. 25, pl. ix, figs. 3—6.

— lævis, *Jones*, 1883. Micrógr. Dict., ed. 4, p. 452, pl. xxiii, figs. 22 *a*, *b*.

— — *Brady*, 1884. Rep. 'Chall.,' pp. 444, 455, pl. lvi, figs. 7—14 and 30.

— — *Jones*, 1884. Quart. Journ. Geol. Soc., vol. xl, p. 769, pl. xxxiv, fig. 3.

— — *Sherborn and Chapman*, 1886. Journ. Roy. Micros. Soc., ser. 2, vol. vi, p. 744, pl. xiv, fig. 13.

— vulgaris, *Terquem*, 1886. Mém. Soc. Géol. Fr., ser. 3, vol. iv, p. 6, pl. vii, fig. 4.

— lævis, *Haeusler*, 1887. Neues Jahrb. for 1887, part 1, p. 181, pl. iv, figs. 31—50; pl. v, figs. 31—35 (two-chambered) and 53.

Lagena lævis, *Malagoli*, 1887. Atti Soc. Nat. Modena (Rend.), ser. 3, vol. iii, p. 109, pl. i, fig. 7.
— — *Brady*, 1888. Geol. Mag., dec. 3, vol. v, p. 481, pl. xiii, figs. 6—10 (including *L. antiqua*, Alcock).
— — *Terrigi*, 1889. Mem. R. Accad. Lincei, ser. 4, vol. vi, p. 112; pl. v, fig. 12; pl. vi, figs. 2, 3.
— — *B., S., and B.*, 1890. Journ. Roy. Micr. Soc., p. 555, pl. ix, fig. 3.
— cincta, *Iidem*, 1890. Ibid., fig. 5.
— lævis, *Fornasini*, 1890. Mem. Accad. Sci. Istit. Bologna, ser. 4, vol. x, p. 466, pl. o, fig. 1.
— — *Idem*, 1893. Ibid., ser. 5, vol. iii, p. 431, pl. ii, fig. 1 (= *Phialina propinqua*, Seguenza).
— — *Meriani*, 1892. B. S. Geol. Ital., vol. x, p. 725, pl. xxi, fig. 9.
— — — 1893. Ann. R. Istit. Udina, ser. 2, ann. xi, p. [22], pl. i, fig. 8.
— — *Chapman*, 1893. Journ. R. Microsc. Soc. for 1893, p. 581, pl. viii, fig. 5.
— — *Idem*, 1894. Quart. Journ. Geol. Soc., vol. l, p. 705.
— — *Egger*, 1893. Abhandl. k. Bayer. Ak. Wiss., vol. xviii, part 2, pp. 321, 323, pl. x, figs. 3—5.
— tubulifera, *Egger*, 1893. Abh. k. Bayer. Ak., vol. xviii, pt. 2, p. 324, pl. xxi, fig. 9.
— lævis, *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 74, pl. xiii, figs. 719—722.

*Characters.*—Flask-like, with globular, oval, pyriform, or subfusiform body, and a produced tubular neck; smooth.

*Occurrence.*—*Lagena lævis* is one of the most common of the *Lagenæ*. It is found in all latitudes and at all depths. Its earliest recorded occurrence in a fossil condition is in the Wenlock Limestone (Upper Silurian, Brady). It has also been found in the Lower Lias of Yorkshire (Blake); in the Middle Lias of France; in the Jurassic of Switzerland (Kübler); in the Neocomian (Bargate Beds) of Surrey; in the Gault of Folkestone; in the Red Chalk of Speeton; in the Upper Chalk of Taplow, Ireland, and Maestricht; in the London Clay; in the Calcaire Grossier of the Paris Basin, in the Oligocene of Elsass and Pietzpuhl; in the Miocene of Piedmont; in the Pliocene of St. Erth, Belgium (Casterlian and Scaldisian), Garrucha (South Spain), and Piedmont. In the Coralline Crag *L. lævis* occurs in all the exposures examined, but rarely, and the specimens are small.

4. Lagena clavata (*d'Orbigny*), 1846. Plate VII, fig. 5.

Oolina clavata, *d'Orbigny*, 1846. Foram. Foss. Vien., p. 24, pl. i, figs. 2, 3.
Ovulina clava, *Ehrenberg*, 1854. Mikrogeol., pl. xxxii, u, fig. 2 *b*.

Lagena vulgaris, var. clavata, *Williamson*, 1858. Rec. Foram. Great Britain, p. 5, pl. i, fig. 6.

— clavata, *Mackie*, 1859. Recreat. Science, vol. i, p. 148, fig. 13.

— acicula, *Reuss*, 1860. Sitz. k. Ak. Wiss. Wien, vol. xlii, p. 355, pl. i, fig. 1.

— clavata, *Reuss*, 1863. Sitz. k. Ak. Wiss. Wien, vol. xlvi, part 1, p. 320, pl. i, figs. 13, 14 (var. *acicularis*).

— lævis, *Blake*, 1876. York. Lias, p. 453, pl. viii, fig. 7 (very short).

— clavata, *Terquem*, 1882. M. S. G. Fr., ser. 3, vol. ii, p. 25, pl. ix, fig. 2.

— — *Brady*, 1884. Report 'Challenger,' pp. 444, 456.

— — — 1888. Geol. Mag.,dec. 3, vol. v, p. 481, pl. xiii, figs. 4 (?), 5.

— — *Egger*, 1893. Abhandl. k. bayer. Ak. Wiss., vol. xviii, part 2, pp. 321, 324, pl. x, fig. 68.

— — *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 75, pl. xiii, figs. 725—727.

*Characters.*—Long-necked, flask-shaped, phyaline, or fusiform, more or less pointed at the base; smooth.

*Occurrence.*—*Lagena clavata* appears to have been found by the 'Challenger' at one station only, namely, that off Heard Island in the South Atlantic, at a depth of 75 fathoms, in a bottom of black mud. Its geological range is extensive, though not many occurrences have been recorded. It has been found in the Upper Silurian (Brady); the Lias of Yorkshire (Blake); the Miocene of Vienna; and the Pliocene of Belgium, Garrucha (South Spain), and St. Erth. In the Coralline Crag we have found it at Sutton only, zone **f**.

5. Lagena gracillima, *Sequenza*, 1862. Plate I, figs. 36, 37.

Part I, 1866, p. 45; and Appendix II, Table, No. 34.

*Additional Synonyms:*

Testæ ovales, oliviformes, pyriformes, fusiformes, &c., *Soldani*. Testaceogr., vol. ii, p. 37, pl. xii, fig. Q.

Amphorina gracilis, *Costa*, 1856. Atti Accad. Pont., vol. vii, fasc. 2, p. 121, pl. xi, fig. 11.

Nodosaria? *Schwager*, 1866. Novara-Reise, Geol. Th., vol. ii, p. 236, pl. vi, fig. 75.

Lagena gracillima, *J., P., and B.*, 1866. Monogr. Foram. Crag, p. 45, pl. i, figs. 36, 37.

— — *Brady*, 1870. Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 292, pl. i, figs. 6 *a—c*.

— — *G. M. Dawson*, 1871. Amer. Journ. Sci., ser. 3, vol. i, p. 206, fig. 10; Ann. Mag. Nat. Hist., ser. 4, vol. vii, p. 87, fig. 10.

Lagena vulgaris, sub-var. distoma-polita, *O. Jones*, 1872. Tr. Linn. Soc. vol. xxx, p. 64, pl. xix, figs. 55—57.
— gracillima, *Brady and Robertson*, 1876. B. Assoc. Rep. for 1875, p. 189.
— — *Bütschli*, 1880. Bronn's Klassen, &c., p. 197, pl. vii, fig. 20.
— — *Fornasini*, 1883. Boll. Soc. Geol. Ital., vol. ii, p. 185, pl. ii, fig. 5.
— — *Brady*, 1884. Report 'Challenger,' pp. 444 and 456, pl. lvi, figs. 19—28.
Indet., *De Folin*, 1877. Le Naturaliste, vol. ix, p. 140, fig. 20 *b*.
Dentalina communis (with shrunken septa), *Haeusler*, 1887. Neues Jahrb. for 1887, part 1, p. 189, pl. v, fig. 50.
Lagena gracillima, *Egger*, 1893. Abhandl. k. bayer. Akad. Wiss., vol. xviii, part 2, p. 330, pl. x, fig. 12.
— — *Chapman*, 1893. J. R. Micr. Soc. for 1893, p. 582, pl. viii, fig. 6.
— — *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 75, pl. xiii, figs. 728—730.

*Characters.*—Test long and slender, broadest near the middle; ends drawn out to fine apertural points.

*Occurrence.*—Very common in the existing seas in almost every latitude, ranging from estuarine shallows to the mid-ocean bed at 2300 fathoms. Fossil specimens have been recorded from the Jurassic of Switzerland (Haeusler); the Cretaceous (?) of Sicily (Ehrenberg); the Gault of Folkestone; the Miocene of Messina; the Pliocene of Sicily, Italy, and St. Erth. In the Coralline Crag it has been met with at Sutton only.

6. Lagena striata (*d'Orbigny*), 1839. Plate I, figs. 38 and 39; Plate VII, fig. 8.

Part I, 1866, p. 35; and Appendix II, Table, No. 27.

*Additional Synonyms :*

Ovulina striata, *Seguenza*, 1862. Foram. Monotal. Mess., p. 40, pl. i, figs. 6, 7.
Phialina Haidingeri, tenuistriata, Gemmellarii, cylindracea, *Idem*, 1862. Ibid., figs. 20, 21, 23, 24.
Lagena striata, *Jones, Parker, and Brady*, 1866. Monogr. For. Crag., p. 35, pl. i, figs. 38—40.
— tenuistriata, *Stache*, 1865. Novara-Reise, Geol. Th., vol. i, p. 184, pl. xxii, fig. 4.
— Nos. 46—50, *Schlicht*, 1870. Pierzpuhl, p. 9, pl. iii, figs. 1—5, 7—11.
— vulgaris, var. striata, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 52, pl. xix, figs. 16, 20.
— — var. striato-areolata, *Idem*, 1872. Ibid., p. 53, pl. xix, fig. 21.

Lagenulina, *Terquem*, 1876. Anim. Plage Dunkerque, fasc. 2, p. 68, pl. vii, fig. 7.
Lagena striata, *Brady and Robertson*, 1876. Rep. Brit. Assoc. for 1875, p. 189.
— Grinzingensis, *Karrer*, 1877. Geol. k. F.-J. Wasserleitung, p. 378, pl. xvi, *b*, fig. 17.
— striata, *Terrigi*, 1880. Atti Acc. P.N. Lincei, vol. xxxiii, p. 177, pl. i, fig. 5.
— — *Möbius*, 1880. Meeresf. Mauritius, &c., p. 89, pl. viii, fig. 3.
— — *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 7.
— — *Green*, 1881. Amer. Journ. Microsc., vol. vi, p. 46, pl. o, fig. 5.
— — *Jones*, 1883. Microgr. Dict., ed. 4, p. 452, pl. xxiii, fig. 24.
— — *Brady*, 1884. Report 'Challenger,' pp. 444 and 460, pl. lvii, figs. 22, 24, 28, 29.
— — *Haeusler*, 1887. Neues Jahrb. for 1887, part 1, p. 184, pl. v, fig. 6.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222, pl. xliv, fig. 28.
— — *Fornasini*, 1893. Mem. Roy. Accad. Sci. Istit. Bologna, ser. 5, vol. iii, p. 431, pl. ii, fig. 2 (= *Phialina cylindracea*, Seguenza).
— — *Egger*, 1893. Abhandl. k. Bayer. Ak., vol. xviii, part 2, p. 327, pl. x, figs. 21—24, 31.
— — *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 75, pl. xiii, figs. 732—736.[1]

*Characters.*—Typically flask-shaped; oval body with tubular neck; marked with delicate, parallel, longitudinal striæ, like delicately engraved lines, but it is often variable in shape of the body, length of neck, and nature of the striæ. In our figured specimen the striæ have a spiral arrangement, but they retain a straighter and more vertical position than those characterising Egger's *L. tortilis* ('Abhandl. K. Bayer. Akad. Wiss.,' vol. xviii, part 2, 1893, p. 329, pl. x, figs. 61—63).

*L. lineata*, Williamson, appears to be the most delicately striate of the *Lagenæ;* and a relative coarseness of this ornament of incised lines increases among the "*striata*" group, until the striæ or thin lines may be said to broaden into furrows or *sulci*. In this aspect the intervals of the striæ may be said to become ridges. These latter, however, may not in all cases be truly homologous with the intervals between the striæ; for on these narrow spaces there often appear to be independent exogenous growths of linear shell-matter, which takes the form of interrupted ridges, granules, linear or diffused, and prickles, coarse or fine, and more or less irregularly scattered.

*Occurrence.*—*Lagena striata* has a very wide geographical range. It is more common in the shallow waters of arctic and antarctic seas. In the temperate and

[1] In the former list of synonyms at p. 35 *Oolina* (*Ovulina*) *sicula*, Ehrenb., is *Lagena sulcata;* and *Lagena vulgaris*, var. *gracilis*, Williamson, is *Lagena gracilis*.

tropical oceans it is found generally at great depths, 1070 to 2740 fathoms; but specimens were obtained by the 'Challenger' in the North Pacific at depths of 40 and 345 fathoms.

As a fossil it is recorded from the Eocene London Clay; the Oligocene of Germany; the Miocene of Italy, Vienna, and Malta; and the Pliocene of Belgium (Scaldisian), Piedmont, and St. Erth. In the Coralline Crag we have it from Broom Hill, zones **d** and **e**, Gedgrave and Sutton, zone **f**.

7. Lagena sulcata (*Walker and Jacob*), 1798. Plate I, figs. 40, 41.

Part I, 1886, page 36; and Appendix II, Table, No. 28.

*Additional Synonyms:*

Orthocerata perfecté globularia, *Soldani*, 1780. Saggio Orittogr., p. 108, pl. vi, fig. 43 *H*.

Polymorpha, Sphærulæ siphunculatæ, *Soldani*, 1791. Testaceograph., vol. i, part 2, p. 116, pl. cxix, fig. *R*; p. 118, pl. cxxix, fig. *cc*.

Oolina sicula, *Ehrenberg*, 1854. Mikrogeol., pl. xxvi, fig. 1.

Entosolenia costata, *Williamson*, 1858. Rec. For. Gt. Brit., p. 9, pl. i, fig. 18.

Ovulina sulcata, varr. elongata et inflata, *Seguenza*, 1862. Foram. Mon. Messin., p. 41, pl. i, figs. 8—10.

Phialina lagena, exigua, incerta, costata, costæ, Reussiana, *Idem*, 1862. Ibid., pp. 46—48, figs. 22, 25—29.

Amphorina Lyellii et costata, *Idem*, 1862. Ibid., p. 52, figs. 40, 41. (Apiculate.)

Lagena cæpulla, *Schwager*, 1866. Novara-Exp. Geol. Theil, vol. ii, p. 205, pl. iv, figs. 20 *a*, *b*.

— sulcata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 36, pl. i, figs. 40 and 41 (42 and 43 = *acuticosta*, Reuss).

— — *Mackie*, 1867. Science Gossip, vol. iii, p. 129, figs. 107 and 108.

— Nos. 31, 52, *Schlicht*, 1870. Pietzpuhl, pp. 7, 10, pl. ii, fig. 10; pl. iii, figs. 14, 20.

— mucronulata, *Reuss*, 1870. Sitz. k. Akad. Wiss. Wien, vol. lxii, p. 467, No. 8; *Schlicht*, 1870, Foram. Pietzpuhl, pl. iii, figs. 18 and 24 (apiculate).

— vulgaris, var. sulcata, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 55, pl. xix, figs. 25, 26.

— — var. bicamerata, *Idem*, 1872. Ibid., p. 65, pl. xix, fig. 62.

— laticosta, *Terquem et Berth.*, 1875. Mém. Soc. Géol. France, ser. 2, vol. x, Mém. iii, p. 15, pl. i (xi), fig. 11.

Lagena sulcata, *Brady and Robertson*, 1876. Rep. Br. Assoc. for 1875, p. 189.
Lagenulina costata, *Terquem*, 1876. Plage Dunkerque, p. 67, pl. vii, fig. 2.
Lagena Natrii, *Blake*, 1876. Yorkshire Lias, p. 453, pl. xviii, fig. 8 (= *? striata*).
— sulcata, *Wright*, 1877. Proceed. Belfast Field Club for 1876–7, Appendix iv, p. 103, pl. iv, fig. 10.
Capitellina multistriata, *Marsson*, 1878. Mitth. Nat. Verein Neu-Vorpom. u. Rügen, Jahrg. x, p. 123, pl. i, fig. 3.
Lagena sulcata, *Vine*, 1878. Science Gossip, vol. xiv, p. 52, fig. 27.
— — *Nicholson*, 1879. Manual Palæont., vol. i, p. 114, fig. 18*f*.
— costata,[1] *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, mém. iii, p. 27, pl. i (ix), fig. 11 (*L. sulcata ?* neckless).
— ornata, *Terquem*, 1882. Ibid., fig. 12.
Lagena sulcata, *Brady*, 1884. Report 'Challenger,' pp. 445 and 462, pl. lvii, figs. 23, 26, 33, 34; pl. lviii, figs. 4, 17, 18; and "winged varieties," p. 462, pl. lxi, figs. 35—37.
— — *Balkwill and Wright*, 1885. Trans. R. I. Acad., vol. xxviii (Sci.), p. 338, pl. xiv, figs. 1 and 2.
— striata, *Sherborn and Chapman*, 1886. Journ. R. Microsc. Soc., ser. 2, vol. vi, p. 745, pl. xiv, fig. 16 (long-necked).
— — var., *Iidem*, 1886. Ibid., fig. 17 (round, with sharp ribs; approaching *acuticosta*).
— sulcata, *Iidem*, 1886. Ibid., fig. 18.
— — *Brady*, 1887. Ibid., vol. for 1887, p. 903.
— costata, *Idem*, 1887. Ibid., p. 184, pl. v, fig. 5 (neckless; strong ribs).
— striata, *Idem*, 1887. Ibid., fig. 6 (neckless; feeble riblets).
— — *Brady*, 1888. Geol. Mag., dec. 3, vol. v, p. 481, pl. xiii, fig. 11.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, fig. 11. No. 7, p. 222, pl. xliv, figs. 18, 22, 34.
— — *Chapman*, 1893. Journ. Roy. Micr. Soc. for 1893, p. 583, pl. viii, fig. 11.
— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 78, pl. xiii, figs. 742—744.

*Characters.*—To the description given at p. 36 of Part I we may add that the riblets not only vary in strength, but in length, sometimes reaching halfway or less from the base to the top (that is, from the aboral to the oral end of the shell), becoming *semistriata*, sometimes alternating, long, and short, as in *interrupta*. Also that the upper end of the striæ may become spiral on the neck, as in *striata;* and the lower ends may either end off distinct around the base, or may be fused together into a mucro.

*Occurrence.*—*Lagena sulcata* is at home in all seas and at nearly all depths, and

[1] It is not possible to determine, in many cases, if the published "costate" and "sulcate" forms have been named strictly in accordance with the plan of their sculpturing.

is one of the most abundant of the *Lagenæ*. Its geological range is likewise very extensive. It has been found in the Upper Silurian of Woolhope (Brady); in the Lower Lias of Yorkshire (Blake); in the Gault of Folkestone (Chapman); in the Upper Chalk of Swanscombe and Taplow (Chapman), and of Keady Hill (Wright); in the Eocene of London Clay; in the Oligocene of Elsass; in the Miocene of Malaga, and of Muddy Creek, Victoria; in the Pliocene of Garrucha (South Spain), Piedmont, Kar-Nicobar, and St. Erth; and in Pleistocene deposits generally. In the Coralline Crag it is rare, but specimens have been found at nearly every zone examined. It has also been found in the Red Crag. It is to be noted that, while *L. sulcata* is rare in the Crag, the closely allied form *L. acuticosta* is very common.

8. Lagena acuticosta, *Reuss*, 1862. Plate I, figs. 42, 43 ("*L. sulcata*," Part I, p. 36).

Lagena acuticosta, *Reuss*, 1862. Sitz. k. Ak. Wiss. Wien, vol. xliv, p. 305, pl. i, fig. 4.
— — *Idem*, 1863. Ibid., vol. xlvi, p. 331, pl. v, fig. 63.
— sulcata (part), *P. and J.*, 1865. Phil. Trans., vol. clv, p. 351, pl. xiii, figs. 30 *a*, *b*, 31 *a*, *b*.
— — ( — ), *J., P., and B.*, 1866. Monogr. For. Crag, p. 36, pl. i, figs. 42, 43 (not 41).
— acuticosta, *Reuss*, 1870. Sitz. k. Akad. Wien., vol. lxii, p. 467, No. 10.
— No. 55, *Schlicht*, 1870. Pietzpuhl, p. 10, pl. iii, figs. 17 and 23.
— acuticosta, *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 9.
— — *Brady*, 1884. Report 'Challenger,' pp. 445 and 464, pl. lvii, figs. 31 and 32; pl. lviii, figs. 20 (?), 21.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222, pl. xliv, figs. 26 *a*, *b*, 31.
— — *Egger*, 1893. Abhandl. k. Bayer. Ak. Wiss., vol. xviii, part 2, pp. 321 and 329, pl. x, figs. 47, 48, 80—84.
— — *Chapman*, 1893. Journ. R. Micr. Soc. for 1893, p. 583, vol. viii, figs. 12 *a*, *b*.
— — *Idem*, 1894. Quart. Journ. Geol. Soc., vol. l, p. 706.

Figs. 42 and 43 were included in *L. sulcata* at page 36 of Part I (1866), and as a "strong form" in the explanation of Pl. I. This is an extreme example of the ridge-growth, and has been separated off by Reuss as having relatively few and large costæ, which he describes as being sometimes (from Pietzpuhl) high and thin. Two good specimens were figured in the 'Phil. Trans.,' 1865, pl. xiii, figs. 30 and 31; and were referred to at page 351 as the best characterised among the group "*sulcata*" by their large size, boldness of growth, strength of the

ribs (twelve to fourteen), and their radiate aperture. They evidently stand with *L. acuticosta* as above described.

*Occurrence.* — *Lagena acuticosta* was found by the 'Challenger' at four stations: in the North Pacific, at a depth of 2300 fathoms; in the Equatorial Pacific, depth 2425 fathoms; in the South Pacific, depth 2350 fathoms; and in the Southern Ocean off Heard Island at a depth of 75 fathoms. It is interesting to notice that the bottom temperature at each of the three Pacific stations was 1° Centigrade.

Its geological history extends to the Cretaceous period. It has been recorded from the Neocomian (Bargate Beds) of Surrey; from the Gault of Folkestone; from the Upper Chalk of Maestricht; and from the Oligocene of Pietzpuhl. We have specimens also from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag it is the commonest of the *Lagenæ*, and the specimens are generally large and well grown.

9. Lagena gracilis, *Williamson*, 1848. Plate VII, figs. 6 *a*, *b*.

Lagena gracilis, *Williamson*, 1848. A. M. N. Hist., ser. 2, vol. i, p. 13, pl. i, fig. 5.
— vulgaris, var. gracilis, *Williamson*, 1858. Rec. Foram. Great Brit., p. 7, pl. i, figs. 12, 13.
— gracilis, *Reuss*, 1863. Sitz. k. Akad. Wiss. Wien, vol. xlvi, part 1, p. 331, pl. iv, figs. 58—61; pl. v, fig. 62.
— — *Schwager*, 1866. Nov.-Exp. Geol., vol. ii, p. 206, pl. iv, figs. 21 *a*, *b*.
— Nos. 40—43, *Schlicht*, 1870. Pietzpuhl, p. 8, pl. ii, figs. 19, 20, 24, 25.
— vulgaris, var. caudata, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 54, pl. xix, fig. 22.
— gracilis, *Siddall*, 1879. Catal. Brit. Rec. For., p. 5.
— — *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 6.
— — *Brady*, 1884. Report 'Challenger,' pp. 445 and 464, pl. lviii, figs. 2, 3, 7, 10, 19, 22—24.
— — *Chapman*, 1893. J. R. Microsc. Soc., p. 563, pl. viii, fig. 13.
— — *Egger*, 1893. Abhandl. k. Bayer. Akad., vol. xviii, part 2, pp. 321, 328, pl. x, figs. 25, 33, 49.
— — *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 77, pl. xiii, fig. 738.

*Characters.*—Long, flask-shaped, phialine, or fusiform; with long or short neck, tapering or apiculate below; bearing longitudinal costulæ, fine or coarse. Figs. 6 *a* and 6 *b* show an individual hexagonal in section, with six rather thick riblets.

*Occurrence.*—*Lagena gracilis* has a wide geographical distribution. It is not uncommon in shallow waters on the western shores of Europe, but the

'Challenger' specimens were obtained for the most part from the deep seas of the Southern Hemisphere, the greatest depth being 2775 fathoms. The fossil distribution extends from the Gault of Folkestone through nearly all formations to the present time. It has been found in the Upper Chalk of Swanscombe and Keady Hill (Ireland); in the London Clay; in the Oligocene of Elsass and Pietzpuhl, the Pliocene of Calabria and Kar-Nicobar, and the Post-pliocene of the north-east of Ireland. In the Coralline Crag we have found only one small specimen at Tattingstone, zone **d**.

10. Lagena semistriata, *Williamson*, 1848. Plate IV, fig. 6.

Part I (1866), page 34, No. 3; and Appendix II, Table, No. 26.

*Additional Synonyms :*

Oolina striaticollis, *Reuss*, 1862. Sitz. Akad. Wien., vol. xlvi, p. 327, pl. iii, fig. 40.

Lagena sulcata (pars), *Parker and Jones*, 1865. Phil. Trans., vol. clv, pp. 348 and 350, pl. xvi, fig. 6.

— semistriata, *J., P., and B.*, 1866. Monogr. Foram. Crag, p. 34, pl. iv, fig. 6.

— — *Mackie*, 1867. Science Gossip, vol. iii, p. 130, fig. 111.

— Nos. 32, 44, 45, *Schlicht*, 1870. Pietzpuhl, pp. 7, 9, pl. ii, figs. 12, 17, 18.

— vulgaris, var. semistriata, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 52, pl. xix, fig. 15.

— — — *Hantken*, 1875. Mitth. Jahrb. Ung. g. Anst., vol. iv, p. 22, pl. xii, fig. 6.

— semistriata, *Zittel*, 1876. Handb. Palæont., part 1, p. 85, fig. 211.

— — *Brady and Robertson*, 1876. Rep. B. Assoc. for 1875, p. 189.

Lagenulina semistriata, *Terquem*, 1876. Plage Dunkerque, p. 68, pl. vii, fig. 8.

Lagena semistriata, *Green*, 1881. Amer. J. Microsc., vol. vi, p. 46, fig. 2.

— tenuis, *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, p. 26, pl. i (ix), fig. 8.

— perlucida, *Schlumberger*, 1882. Fenille J. Nat., ann. xii, pl. i, fig. 2.

— semistriata, *Jones*, 1883. Microgr. Dict., edit. 4, p. 452, pl. xxiii, fig. 25.

— — *Brady*, 1884. Report 'Challenger,' pp. 445 and 465, pl. lvii, figs. 14, 16, 17.

— — *Quenstedt*, 1885. Handb. Petref., ed. 3, part 5, p. 1049, pl. lxxxvi, fig. 2.

— — *Wright*, 1886. Proc. Belfast F. Club, Appendix ix, p. 324, pl. xxvi, fig. 6.

— sulcata, *Haeusler*, 1887. Neues Jahrb. for 1887, part 1, pp. 183 and 189, pl. v, figs. 1—4 (short and imperfect ribs); and figs. 38 and 39 (bilocular, "or *Nodosaria raphanus*").

Lagena semistriata, *Steinmann*, 1888. Elem. Paläont., vol. i, p. 27, fig. 8 a.
— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 321, 327, pl. x, figs. 34, 39.
— semistriata, *Goës*, 1894. K. Sven. Vet.-Akad. Handl., vol. xxv, No. 9, p. 76, pl. xiii, fig. 737.

*Characters.*—This intermediate form is characterised by variable riblets, generally strong and wide-apart, reaching upwards from the base towards the middle of the shell. There are no sunken striæ.

Dr. G. C. Wallich figured a semistriate entosolenian *Lagena* in "The North Atlantic Sea-bed," 1862, pl. v, fig. 17, without description. An interesting example of a double growth of *L. semistriata* is shown by fig. 22, pl. vii, of Bütschli's descriptive part of Bronn's 'Klassen, &c., Thier-Reichs,' 1880.

*Occurrence.*—*Lagena semistriata* has a wide range in recent seas. It has been recorded from Hunde Islands, Davis Strait, at a depth of 25—70 fathoms; from Novaya Zemlya, 10—219 fathoms; Kerguelen Island, 29—120 fathoms; and West Coast of Patagonia, 40—175 fathoms. In the North Pacific it has been found at depths of from 2300 to 3125 fathoms; in the South Pacific at depths of from 2325 to 2350. Off the Azores it has been found at a depth of 1000 fathoms; off the North-west Coast of Ireland at a depth of 1443 fathoms. It is interesting to notice, from the details given in the 'Challenger' Report, that the bottom temperature where the deep-water specimens were obtained was 1° Cent. It would thus appear that *L. semistriata* is a cold-water form.

Records of the occurrence of *L. semistriata* in a fossil condition are rare. It has been found in the Oligocene of Hermsdorf, the Miocene of Bavaria and Messina, the Pliocene of Antwerp (Reuss) and St. Erth; and we have well-developed specimens in our own Collection from the Pleistocene of Gourock, near Greenock. In the Coralline Crag, in addition to the occurrence at Sutton previously recorded, we have found it at Gedgrave, zone **f**.

11. Lagena melo (*d'Orbigny*), 1847. Plate I, fig. 35.

Part I, 1866, p. 38, No. 6; and Appendix II, Table, No. 29.

*Additional Synonyms:*

Polymorpha. Sphærulæ siphunculatæ, *Soldani*, 1791. Testac., &c., vol. i, part 2, p. 116, pl. cxx, fig. *b b* (?).
Entosolenia squamosa, var., *J. W. Dawson*, 1859. Canad. Nat., vol. iv, p. 29, fig. 10.
Lagena melo, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 38, pl. i, fig. 35.
— — *Mackie*, 1867. Science Gossip, vol. iii, p. 129, fig. 109.

Entosolenia melo, *G. M. Dawson*, 1870. Canad. Nat., N.S., vol. 5, p. 178.
Lagena[1] (bilocular), *Parker, Jones, and Brady* (*Soldani*[2]), 1871. Ann. Mag. Nat. Hist., ser. 4, vol. viii, p. 157, pl. ix, fig. 33 (= *Nodosaria cancellata*, d'Orb., 1826, Ann. Sci. Nat., vol. vii, p. 254, No. 29).
— melo, *Brady and Robertson*, 1876. Brit. Assoc. Rep. for 1875, p. 190.
— — *Bütschli*, 1880. Bronn's Klassen, &c., p. 197, and explanation of plate, pl. vii, fig. 11.
— — *Brady*, 1884. Report 'Challenger,' p. 446.
— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222, pl. xliv, figs. 21, 24, 25.

Fig. 19. Fig. 20. Fig. 21.

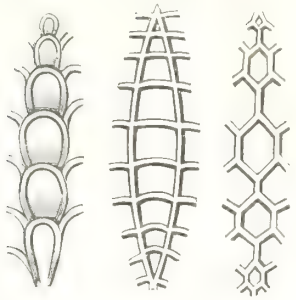

Fig. 19.—Diagram of the ornamentation of *Lagena squamosa* (Montagu).

Fig. 20.—Diagram of the ornamentation of *Lagena melo* (d'Orb.).

Fig. 21.—Diagram of the ornamentation of *Lagena hexagona*, Williamson.

*Characters.*—For varietal forms of this reticulate *Lagena* with subquadrangular meshes we may point to figs. 21 and 24, pl. xliv, 'Trans. Zool. Soc.,' 1888, both as to its shape and the somewhat variable character of the transverse bars, which in *L. catenulata*, Williamson, become as straight and thick as the longitudinal ridges; also to fig. 25, in which the cross-bars have been formed only on the upper moiety of the shell (*L. sulcata*), just as similar but oblique bars occur on the upper part of fig. 34, pl. xiii, 'Phil. Trans.,' 1865. In figs. 35 and 36 of the same plate these interstitial bars have an upward curvature, characterising *Nodosaria cancellata*, d'Orbigny (see above). The curve, however, of some only of the bars in *L. melo* is a very different condition from that in *L. squamosa;* for in the latter each areole represents, as it were, a loop bent in between the verticals (see diagram, fig. 19), whilst in *L. melo* (diagram, fig. 20) each cross-bar, whether quite straight or somewhat bent, passes direct from one vertical to the other.

The *Lagena* described and figured by Terrigi, 'Mem. R. Accad. Lincei,' ser. 4, vol. vi, 1889, p. 112, pl. vi, fig. 1, with doubt as *L. melo*, evidently has some alliance with Brady's *L. faveso-punctata*.

*Occurrence.*—*Lagena melo* has been found in the living condition in British seas (Williamson, Brady), in the North Atlantic and Arctic waters (Parker and Jones), in the Mediterranean (Jones and Parker), and originally on the South

[1] This is figured also in 'Phil. Trans.,' 1865, pl. xiii, fig. 36, and, together with fig. 35, would come under *L. squamosa*, as defined by Brady, if the arched tops of the areolæ were really distinctive, but they are not.

[2] 'Testac.,' &c., vol. i, p. 91, pl. xcv, fig. a.

American littoral by d'Orbigny. No specimen was obtained from the 'Challenger' dredgings. We note its occurrence as a fossil from the Eocene of the London Clay, the Miocene of Messina (Seguenza) and Muddy Creek, Victoria, and from the Pliocene of St. Erth. We have specimens also in our own collection from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag we have specimens from every locality examined except Aldborough.

12. Lagena hexagona (*Williamson*), 1848. Plate VI, fig. 7.

Entosolenia squamosa, var. hexagona, *Williamson*, 1848. A. M. N. H., ser. 2, vol. i, p. 20, pl. ii, fig. 23.
— — — — *Idem*, 1858. Rec. Foram. Gt. Brit., p. 13, pl. i, fig. 32.
— — — scalariformis, *Idem*., 1858. Ibid., fig. 30 (very large areolæ).
Lagena squamosa, *Parker and Jones*, 1862. Introd. Foram., Appendix, p. 309.
— scalariformis (part), *Reuss*, 1862. Sitz. k. Akad. Wiss. Wien, vol. xlvi, p. 333, pl. v, fig. 69 (very large areolæ).
— favosa, *Idem*, 1862. Ibid., p. 334, pl. v, figs. 72, 73 (large, and very large areolæ).
— geometrica, *Idem*, 1862. Ibid., fig. 74 (small areolæ).
Ovulina ornata, *Seguenza*, 1862. Foram. Monotal. Messin., p. 42, pl. i, fig. 12 (large areolæ).
Phialina ornata, *Idem*, 1862. Ibid., p. 48, fig. 30 (small areolæ).
Lagena sulcata, var. (Entosolenia) squamosa, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 354, pl. xvi, figs. 11 *a*, *b*.
— geometrica, *Hantken*, 1875. Mitth. Jahrb. Ung. g. Anst., vol. iv, p. 22, pl. xii, fig. 8.
— Mariæ, *Karrer*, 1877. Geol. F.-J. Wasserl., p. 378, pl. xvi *b*, fig. 16.
— hexagona, *Siddall*, 1879. Catal. Brit. Rec. Foram., p. 6.
— squamosa, var. hexagona, *B. and R.*, 1876. R. B. Assoc. for 1875, p. 190.
— hexagona, *Green*, 1881. Amer. Journ. Microsc., vol. vi, p. 46, fig. 41.
— — *Brady*, 1884. Report 'Challenger,' pp. 446 and 472, pl. lviii, figs. 32, 33.
— — *Egger*, 1893. Abhandl. k. Bayer. Ak. Wiss., vol. xviii, part 2, p. 326, pl. x, fig. 60.

*Characters.*—*Lagenæ*, presenting various modifications of the flask-like shape, which have a surface-reticulation of equally raised meshes, forming large or small hexagons regularly disposed. See the diagram, fig. 21, p. 192.

*Occurrence.*—*Lagena hexagona* has a wide bathymetrical range. The 'Challenger' specimens were obtained at depths ranging from 40 to 2425 fathoms, but exclusively from stations in temperate and tropical seas. It is worthy of note that no specimen of *L. hexagona* is recorded in the 'Challenger' Report from the dredgings in high latitudes, whereas *L. squamosa* was found commonly in those areas.

The geological history of *L. hexagona*, like that of its congeners *L. melo* and *L. squamosa*, is not known at present to extend beyond the Tertiary period. It has been found in the Oligocene of Elsass, the Miocene of Italy, Vienna, and of Muddy Creek (Victoria), the Pliocene of Garrucha (South Spain), Piedmont, and St. Erth, and in beds of Pleistocene age in Scotland and Ireland. We have ourselves found it in the Scaldisian of Antwerp. In the Coralline Crag it occurs at Broom Hill, zone **d**, Gedgrave, zone **f**, and Sutton, zones **e** and **f**.

13. Lagena seminuda, *Brady*, 1884. Plate VI, figs. 8 *a*, *b*.

Lagena seminuda, *Brady*, 1884. Report 'Challenger,' pp. 446 and 472, pl. lviii, figs. 34 *a*, *b*.

*Characters.*—Test subglobular or somewhat pyriform; orifice in a crater-like depression on the truncate oral extremity; surface ornament consisting of a raised reticulation (hexagonal in Pl. VI, fig. 8, and less regular in Brady's figure), confined to the lower half of the shell; the remainder being smooth.

The striking characteristic of *L. seminuda* is its truncate oral end, and this feature is very constant. Of the many specimens found in the Coralline Crag, not one shows any approach to a produced neck. In its surface ornamentation *L. seminuda* presents the same relation to *L. hexagona* as *L. costata*, Williamson, does to *L. sulcata*, W. and J., and *L. semistriata*, Williamson, to *L. striata*, d'Orbigny. In *L. seminuda*, *L. costata*, and *L. semistriata* the specific ornamentation is located on the posterior portion of the test, and may partially invest the shell to a greater or less degree anteriorly. It appears to be a characteristic of the *Lagenæ* that where only a portion of the test is furnished with a particular type of ornamentation, that portion includes the aboral extremity.

*Occurrence.*—*L. seminuda* was described for the first time by Brady in the 'Challenger' Report. On reference to the tables at the end of the Report we find that the 'Challenger' specimens were obtained from the temperate zone at depths ranging from 1375 to 2350 fathoms. The bottom temperatures varied from 0·4° C. to 1·5° C. In the body of the Report, Brady states that it has been found in shallower waters in the North Atlantic.

*L. seminuda* has lately been recorded by Mr. Millett from the Pliocene of St. Erth, where it is stated to be rare. We have also found a single specimen in the Scaldisian of Antwerp. In the Coralline Crag we have found it rather commonly at Sutton, zone **f**, and less frequently at Broom Hill, zone **d**, Gedgrave, zone **f**, and Aldborough, zone **g**.

14. Lagena reticulata (*Macgillivray*), 1843. Plate IV, fig. 7 ("*L. squamosa*").

Part I, 1866, page 39, No. 7 ("*L. squamosa*"); and Appendix II, Table, No. 30.

*Corrected Synonymy:*

Orbulina aterrima, *Costa*, 1838. Faun. Regn. Nap., p. 4, pl. iii, fig. 7.
Lagenula reticulata, *Macgillivray*, 1843. Moll. Anim. Aberdeen, &c., p. 38.
Entosolenia squamosa, *Williamson*, 1848. Ann. Mag. Nat. Hist., ser. 2, vol. i, p. 18, pl. ii, fig. 19.
— typica, *Idem*, 1858. Rec. Foram. Gt. Brit., p. 12, pl. i, fig. 29.
— reticulata, *Reuss*, 1862. Sitz. k. Akad. Wiss. Wien, vol. xliv, p. 333, pl. v, figs. 67, 68.
— — *Idem*, 1863. Bull. Acad. Roy. Belg., ser. 2, vol. xv, p. 144, pl. i, fig. 16.
— anomala, *Stache*, 1865. Novara-Exped. Geol. Thiel., vol. i, part 2, p. 183, pl. xxii, fig. 5.
Lagena sulcata, var. squamosa, *P. and J.*, 1865. Phil. Trans., vol. clv, p. 354, pl. xiii, figs. 40, 41.
— squamosa, *J., P., and B.*, 1866. Mon. For. Crag, p. 39, pl. iv, fig. 7.
Entosolenia squamosa, *Dawson*, 1866. Handb. Zool., p. 44, fig. 33 (1st fig.).
Lagena reticulata, *Bütschli*, 1880. Bronn's Klassen, &c., p. 197, pl. vii, fig. 10.
— — *Terquem*, 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, p. 28, pl. i (ix), fig. 15.
— hexagona ?, var., *Balkwill and Millett*, 1884. Journal of Microscopy, &c., vol. iii, pp. 79 and 89, pl. i, fig. 10.
— — *Goës*, 1894. K. Svensk. V. Handl., vol. xxv, No. 9, p. 80, pl. xiii, fig. 746.

*Characters.*—Fig. 7, Pl. IV, described as *L. squamosa* (from Bridlington) at page 39 of Part I, represents one of the *Lagenæ* which have a delicate superficial network of irregularly shaped meshes, without any orderly arrangement; and doubtless, except for its more delicate reticulation, quite corresponds with *L. reticulata* (Macgillivray), adopted by Reuss, but needlessly grouped with *squamosa* by Brady.

*Occurrence.*—*L. reticulata* exists in the Arctic Ocean and in the British seas. In the fossil state it occurs in the Eocene Tertiary of the Paris Basin, in the Diestian of Antwerp, and in a Tertiary Marl of New Zealand. The figured specimen was from Bridlington, and, though not from the Pliocene Crag, we describe it here both in correction of a former error, and on account of its close relation to *L. hexagona* and its allies.

14*. *Note on* Lagena squamosa (*Montagu*), 1803. Diagram, woodcut, fig. 19.

At page 39 of Part I, 1866, *Lagena reticulata* was mistaken as typical of *L. squamosa;* and one specimen of the latter species had been obtained from the Pleistocene bed at Bridlington, then regarded as "Crag" of Pliocene age (page 40). Although not coming within our present list of the Foraminifera of the Crag, it is of sufficient interest for us to offer here some remarks on *L. squamosa.*

In the 'Philos. Transact.,' 1865, p. 354, Parker and Jones referred the name "*squamosa*" to such *Lagenæ* as have both four- and six-sided areolæ formed of the longitudinal and cross ridges; and for illustration gave figs. 40 and 41 in pl. xiii, and figs. 11 *a*, *b*, in pl. xvi; the first set having delicate hexagons, diffused over the surface without any definite order (*L. reticulata*); and the latter having the meshes in a vertical succession (*L. hexagona*). In his Report of the 'Challenger,' p. 471, H. B. Brady has shown that *L. squamosa* (Montagu) has a vertical and parallel arrangement of subquadrangular areolæ, arched (convex) on their upper borders, and corresponding with Montagu's obscure sketch. Brady's figs. 28 and 29 still more closely match Wallich's fig. 21, pl. v, in 'The North Atlantic Sea-bed,' 1862.

*Characters.*—In *L. squamosa* the interstitials do not coalesce with or pass into the verticals at right angles, but have their ends curved down against the latter, so as to appear to pass below the curve next below. See the diagram, fig. 19, page 192.

A near ally to *L. squamosa* is evidently Seguenza's *Orbulina foveolata*, 'Mioc. Monot. Messin.,' 1862, p. 37, pl. i, figs. 1, 2. This is represented as globose, with a radiate aperture in its flattened apex, and ornamented with nearly vertical rows of subpolygonal little pits, which have a squamose appearance on the sides, and are represented in the end view as having raised interstices.

*Occurrences.*—*Lagena squamosa* is most commonly found in the shallow waters of high latitudes; but specimens were obtained by the 'Challenger' from comparatively shallow waters (390 to 410 fathoms) off the Danish West Indies, and off Sydney, New South Wales. Specimens were also found at one station in the North Pacific (2300 fathoms), and at another in the South Atlantic (1990 fathoms).

The geological range of *L. squamosa* has not hitherto been found to extend beyond the Tertiary deposits. It has been met with in the Eocene (Calcaire grossier) of the Paris Basin, in the Miocene of Messina, and in the Pliocene of Belgium and St. Erth. The specimen recorded as *L. squamosa* in the First Part of the Monograph is *L. reticulata*, of Pleistocene age, from Bridlington.

15. Lagena lævigata (*Reuss*), 1849. Plate VII, fig. 14.

Fissurina lævigata, *Reuss*, 1849. Denks. k. Akad. Wiss. Wien, vol. i, p. 366, pl. xlvi, figs. 1 *a*, *b*.
— globosa, *Bornemann*, 1855. Zeitsch. Deutsch. Geol. Ges., vol. vii, p. 317, pl. xii, fig. 4.
— simplex (?), *Seguenza*, 1862. For. Monot. Mess., p. 56, pl. i, fig. 44.
— deltoidea, *Idem*, 1862. Ibid., p. 57, pl. i, fig. 45.
— latistoma, *Idem*, 1862. Ibid., figs. 46, 47.
— Biancæ, *Idem*, 1862. Ibid., figs. 48—50.
— acuta, *Idem*, 1862. Ibid., fig. 51.
Lagena vulgaris, var. fissurina, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 51, pl. xix, figs. 6—8.
— lævigata, *Terrigi*, 1880. Atti Accad. Pont. Nuovi Lincei, vol. xxxiii, p. 177, pl. i, fig. 6.
— — *Robertson*, 1883. Trans. Geol. Soc. Glasgow, vol. vii, p. 24.
— — *Brady*. Rep. 'Chall.,' pp. 446 and 473, pl. cxiv, figs. 8 *a*, *b*.
— — *Balkwill and Millett*, 1884. Journal Microscopy, vol. iii, pp. 80, 81, pl. ii, fig. 6; pl. iii, fig. 6.
— — *B., P., and J.*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222.
— lucida, *Fornasini*, 1888. B. S. Geol. Ital., vol. viii, p. 47, pl. iii, figs. 5, 5 *a*.

*Characters.*—Pyriform, compressed, the two faces rather convex, the transverse section suboval, aperture entosolenian and narrow, with a short external neck.

*Occurrence.*—*Lagena lævigata* is one of the most common and widely distributed of recent *Lagenæ*. It was found by the 'Challenger' at depths ranging from 2 to 3125 fathoms. It is likewise very common as a fossil, chiefly from Tertiary deposits. It has been recorded from the Chalk of Rügen (Marsson); from the Calcaire Grossier of the Paris Basin; from the Oligocene of Elsass and Pietzpuhl; from the Miocene of Messina and Vienna; from the Pliocene of Messina and St. Erth; and from the Pleistocene of Scotland. We have found it also in the Casterlian and Scaldisian of Antwerp. In the Coralline Crag we have noticed its occurrence only at Tattingstone and Broom Hill, both in zone **d**.

16. Lagena quadrata (*Williamson*), 1858. Plate VII, fig. 9.

Entosolenia marginata, var. quadrata, *Williamson*, 1858. Rec. Foram. Gt Britain, p. 11, pl. i, figs. 27, 28.
Fissurina Pecchiolii, *Sequenza*, 1862. For. Mon. Messin., p. 58, pl. i, fig. 52.
— recta, *Idem*, 1862. Ibid., fig. 53.
— oblonga, *Idem*, 1862. Ibid., p. 68, pl. ii, fig. 35.
— lucidia, var. quadrata, *Reuss*, 1863. Sitz. Ak. Wien, vol. xlvi, p. 324, pl. iii, fig. 26.
Entosolenia quadrata, *Chimmo*, 1870. Bed of Atlantic, p. 28, pl. x, fig. 2.
— — *Möbius*, 1880. Meeresf. Mauritius, p. 90, pl. viii, fig. 9.
Lagena quadrata, *Brady*, 1884. Report 'Challenger,' pp. 446 and 475, pl. lix, figs. 3 and 16; pl. lx, fig. 5.
— — *Balkwill and Millett*, 1884. Journ. Microscopy, vol. iii, p. 81, pl. ii, fig. 8.
— lævigata, var. quadrata, *Wright*, 1886. Proc. Belfast N. Club, p. 324, pl. xxiv, fig. 9.
— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, part 2, p. 331, pl. x, figs. 78, 79.
— compressa, *Egger*, 1893. Ibid., figs. 1, 2.

*Characters.*—This compressed, subquadrate Lagena is near to *lævigata*. Although very variable, it always has a tendency to assume the form of a parallelogram, with more or less rounded extremities; and sometimes a considerable exogenous growth thickens the edges with a keel, either blunt, sharp, or imperfect.

*Lagena Seguenziana*, Fornasini, 'Boll. Soc. Geol. Ital.,' vol. v, 1886, pp. 350—353, pl. viii, figs. 1—8, belonging to the group of *L. lævigata* and *L. quadrata*, is an interesting species, of which six varieties are figured (as above quoted). It is characterised as being compressed, subdiscoidal, with a thick edge or margin and strong projecting neck.

*Occurrence.*—*Lagena quadrata* is stated in the 'Challenger' Report to be confined apparently to comparatively shallow waters,—depths not exceeding 150 fathoms. No mention of the species occurs, however, in the Tables of Distribution given at the end of the Report. It has been recorded by Balkwill and Millett among the Foraminifera of Galway. As a fossil it occurs in the Miocene of Messina, the Pliocene of Messina and St. Erth, and the Pleistocene of North-east Ireland. We have specimens also from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag it occurs (but rarely) in nearly every zone examined.

17. Lagena marginata, *Walker and Jacob*, 1784. Plate I, figs. 33, 34; Woodcut fig. 22.

Part 1, 1866, page 41; and Appendix II, Table, No. 31.

*Additional Synonyms:*

Lagena marginata, *Brown*, 1827. Illustr. Conch. Gt. Brit., fly-leaf, vol. i, pl. i, figs. 30, 31; and 2nd edit., 1844, p. 3, pl. lvi, figs. 30, 31.

— — *J., P., and B.*, 1866. Monogr. Foram. Crag, p. 41, pl. i, figs. 33, 34.

Fissurina alata, *Reuss*, 1870. Sitz. k. Akad. Wiss. Wien, vol. lxii, p. 469, No. 2.

— No. 71, 72, 78, *Schlicht*, 1870. Foram. Pietzpuhl., pp. 13, 14, pl. iv, figs. 7—9, 13—15; pl. v, figs. 19—21.

Lagena vulgaris, var. petasma-marginata, *O. Jones*, 1872. Trans. Linn. Soc., vol. xxx, p. 58, pl. xix, figs. 38, 39.

— — var. bracteato-marginata, *Idem*, 1872. Ibid., p. 59, pl. xix, figs. 40, 41.

— — var. alato-marginata, *Idem*, 1872. Ibid., p. 60, pl. xix, fig. 44.

— — var. clavato-marginata, *Idem*, 1872. Ibid., fig. 45.

— — var. pertuso-marginata, *Idem*, 1872. Ibid., p. 61, pl. xix, figs. 46, 67.

— marginata, *Brady and Robertson*, 1876. R. Brit. Assoc. for 1875, p. 189.

Entosolenia marginata, *Möbius*, 1880. Meeresf. Mauritius, p. 90, pl. viii, figs. 7, 8.

Lagena (Entosolenia) marginata, *Bütschli*, 1880. Bronn's Klassen., &c., p. 197, pl. vii, figs. 13, 14, and 22 *a*.

— marginata, *Wright*, 1881. Proc. Belfast F. Club for 1880–81, Appendix, p. 181, pl. viii, figs. 4, 4 *a*.

— — *Green*, 1881. Amer. Journ. Microsc., vol. vi, p. 46, fig. 8.

Fissurina marginata, *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, p. 30, pl. i (ix), fig. 22.

Lagena marginata, *Brady*, 1884. Rep. 'Chall.,' pp. 446 and 476, pl. lix, figs. 21—23.

— — *Balkwill and Millett*, 1884. Journ. Microscopy, vol. iii, p. 81, pl. v, fig. 2, and fig. 8 (variety).

— — *Haeusler*, 1887. Neues Jahrb. for 1887, part 1, p. 186, pl. iv, figs. 51—53.

— — *B., P., and J.*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222, pl. xliv, figs. 27, 29 (trigonal), 30, and 32.

Fissurina alata, *Franzenau*, 1889. Math. Termés zetrajzi Erlesita, vol. vii, p. 68, pl. iii, fig. 4.

Lagena marginata, var. triaculeata, *Fornasini*, 1891. For. Plioc. del Ponticello di Savena, pl. ii, fig. 12.

— — *Chapman*, 1893. Journ. R. Microsc. Soc. for 1893, p. 584, pl. viii, figs. 16 *a*, *b*.

— — var. caterinlosa, *Chapman*, 1895. Proc. Zool. Soc., p. 26, pl. i, fig. 5.

Lagena marginata, *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 321 and 332, pl. x, figs. 20, 66, 67, 96, 97.

— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 81, pl. xiii, figs. 748—751.

Fig. 22.—*Lagena marginata* (Montagu). (From the 'Phil. Trans.,' vol. clv, pl. xvi, fig. 12 *a*.)

*Characters.*—Sublenticular, pyriform or oval (occasionally trigonal), more or less compressed; keeled or winged at the edge; aperture entosolenian, narrow; base sometimes spinose.

*Occurrence.*—*Lagena marginata* is found in all latitudes and at all depths. Its geological range is likewise extensive. It has been recorded from the Gault of Folkestone; the Chalk of the island of Rügen; the Eocene (London Clay, and the Calcaire Grossier); the Oligocene of Germany (Pietzpuhl); the Miocene of Malaga, Messina, Vienna, and Muddy Creek (Victoria); the Pliocene of Italy and St. Erth; and from various Pleistocene formations. We have in our own collections specimens from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag *L. marginata* occurs with varying frequency in every zone examined. It has also been recorded from the Red Crag.

18. Lagena seminiformis, *Schwager*, 1866. Plate VII, fig. 10.

Miliola stiligera? *Ehrenberg*, 1854. Mikrogeol., pl. xxxi, fig. 6.

Lagena seminiformis, *Schwager*, 1866. Novara-Exped. Geol. Theil., vol. ii, p. 208, pl. v, fig. 21.

Entosolenia marginata? *Chimmo*, 1878. Nat. Hist. Euplectella, p. 21, pl. vi, figs. 20 *a—d*.

Fissurina diptera, *Seguenza*, 1880. R. Accad. Lincei, ser. iii, vol. vi, p. 332, pl. xvii, fig. 36.

Lagena seminiformis, *Brady*, 1884. Report 'Challenger,' pp. 447 and 478, pl. lix, figs. 28—30.

*Characters.*—Body circular, biconvex; with broad peripheral wing, extended at the base so as to form two points separated by a wide central depression.

*Occurrence.*—*Lagena seminiformis* was found by the 'Challenger' at several stations, but invariably in very deep water (1000 to 2350 fathoms). As a fossil it has been recorded from the Chalk of Volsk (Ehrenberg), and from the Pliocene of Kar-Nicobar and St. Erth. One specimen only has been found in the Coralline Crag. It comes from Broom Hill, zone **d**.

19. Lagena lagenoides (*Williamson*), 1858. Plate I, figs. 29—31.

Part I, 1866, page 43, No. 9 (*L. ornata*); and Appendix II, Table, No. 32.

*Corrected Synonymy:*

Entosolenia marginata, var. lagenoides, *Williamson*, 1858. Rec. For. Gt. Brit., p. 11, pl. i, figs. 25, 26.
Lagena lagenoides, *Reuss*, 1862. Sitz. k. Akad. Wiss. Wien, vol. xlvi, p. 324, pl. ii, figs. 27, 28.
Fissurina trapezoidea, *Seguenza*, 1862. For. Mon. Messin., p. 68, pl. ii, fig. 34.
— Reussiana, *Idem*, 1862. Ibid., p. 69, pl. ii, fig. 40.
— radiata, *Idem*, 1862. Ibid., p. 70, pl. ii, figs. 42, 43.
Lagena ornata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 43, pl. i, figs. 29—31.
— formosa, *Schwager*, 1866. Nov.-Exped. Geol. II, p. 206, pl. iv, fig. 19 *b*, *c*.
Entosolenia marginata, var. ornata, *G. M. Dawson*, 1870. Canad. Nat., N.S., vol. v, p. 177, pl. o, fig. 12.
Lagena lagenoides, *O. Jones*, 1872. Tr. Linn. Soc., vol. xxx, p. 59, pl. xix, fig. 42.
— vulgaris, var. marginata, *Idem*. 1872. Ibid., p. 55, pl. xix, fig. 32.
— — var. spinosa-marginata, *Idem*., 1872. Ibid., p. 59, pl. xix, p. 43.
— tubulifera, *Brady*, 1881. Q. J. Micros. Soc., N.S., vol. xxi, p. 61.
— lagenoides, *Idem*, 1884. Report 'Challenger,' pp. 447 and 479, pl. lx, figs. 6, 7, 9, 12—14.
— — *Balkwill and Millett*, 1884. Journ. Microscopy, vol. iii, p. 82, pl. ii, fig. 11.
— — *Balkwill and Wright*, 1885. Trans. R. I. Acad., vol. xxviii (Sci.), p. 341, pl. xii, fig. 22.
— — *B., P., and J.*, 1888. Trans. Zool. Soc., vol. xii, No. 7, p. 223, pl. xliv, fig. 23.
— — *Egger*, 1893. Abhandl. k. Bayer. Ak. Wiss., vol. xviii, part 2, p. 335, pl. x, fig. 85, and figs. 19, 87, and 88 (?), named *seminiformis*, but not described.
— serrata, *Schlumberger*, 1894. Mém. Soc. Zool. Fr., vol. vii, p. 258, pl. iii, fig. 7.

*Characters.*—Although homologous, the *cellulated* margin of Williamson's *ornata* is sufficiently distinct from the *tubulated* margin of his *lagenoides* to make the adoption of the latter name preferable.

*Occurrence.*—*Lagena lagenoides* has a considerable geographical and bathymetrical range. It is not uncommon off the coasts of the British Isles, appears to be more common in the North Atlantic, and occurs with less frequency in the South Atlantic and South Pacific. The depths from which it has been obtained range between 38 and 2740 fathoms.

Fossil specimens have been recorded from the Miocene of Messina (Seguenza), and from the Pleistocene of Canada and the North-east of Ireland. The Crag specimens were obtained from Sutton.

20. Lagena formosa, *Schwager*, 1866. Plate VI, fig. 6.

Lagena formosa (pars), *Schwager*, 1866. Novara-Exped. Geol., vol. ii, p. 206, pl. iv, figs. 19 *a* and *d* (Young ?).

— — *Brady*, 1884. Report 'Challenger,' pp. 447 and 480, pl. lx, figs. 10, 18—20; 8 ? and 17 ?

*Characters.*—Body long, flask-shaped, compressed, with tubulated wing, frequently emarginate at the base, and with a raised border immediately surrounding the body on both sides of the shell. Our example from the Crag is destitute of the fine broad flange or wing present in more typical specimens.

*Occurrence.*—*Lagena formosa* was found by the 'Challenger' at several stations, but for the most part in very deep water, 1075 to 2750 fathoms. Small or broken specimens were found in the Southern Ocean at depths of 50—150 fathoms. As a fossil it has previously been recorded only from the Pliocene of Kar-Nicobar. We have, however, large specimens from the Casterlian and Scaldisian of Antwerp. In the Coralline Crag we have found it (but rarely) in every zone examined except at Aldborough (zone **g**).

20*. Lagena formosa, *Schwager*, var. comata, *Brady*, 1884. Plate VII, fig. 7.

Lagena formosa, var. comata, *Brady*, 1884. Report 'Challenger,' pp. 447 and 480, pl. lx, fig. 22.

*Characters.*—Form similar to that of *L. formosa*, but the body of the shell is marked with longitudinal striæ and thin rugulæ in Brady's fig. 22. Although our specimen from the Crag is marked with fewer and coarser costulæ, and has no broad marginal flange, yet it evidently comes into the same category of sub-varieties of the *lagenoides* sub-type as the foregoing forms.

*Occurrence.*—*Lagena formosa*, var. *comata*, Brady. This sub-variety, characterised by the striate surface of the body-chamber, was first recorded in the 'Challenger' Report from the North Pacific (1850 fathoms). We have found a well-developed specimen in the Scaldisian of Antwerp. The example figured in Plate VII, fig. 7, is from Sutton, zone **f**.

21. Lagena annectens, sp. nov., *Burrows and Holland*. Plate VII, figs. 11 *a*, *b*.

Lagena lævigata, pars, *Reuss*, 1870. Sitz. k. Ak. Wiss. Wien, vol. lxii, p. 16.
Fissurina, No. 75, *Schlicht*, 1870. Pietzpuhl, p. 13, pl. v, figs. 7—9.
Lagena quadricostulata, pars, *Brady* (non *Reuss*), 1884. Report 'Challenger,' p. 486, pl. lix, fig. 15.

*Characters.*—Test pyriform, compressed, entosolenian, aperture fissurine; periphery carinate or non-carinate, sometimes notched at the aboral extremity. Each face of the test ornamented with two narrow curved surface-markings or shallow sulci, parallel with the margins, and occasionally uniting in a horseshoe form.

This species at first sight bears a strong resemblance to *L. quadricostulata*, Reuss; but the ornamentation consists not of arched costulæ, as in the latter species, but of marks apparently due to a structural difference in the shell-substance along the lines of the curves on the surface. In recent and some fossil specimens, where the test is clear and glassy, the markings have the appearance of frosted bands. This is well shown in Schlicht's figures quoted above, and in several of the 'Challenger' specimens which are preserved in the British Museum, and which we have carefully examined. It is possible that this effect is produced by minute tubuli in the shell-walls; but we have as yet been unable satisfactorily to determine this point. In fossil specimens the "frosted" bands are sometimes replaced by shallow sulci, probably due to an erosion of the shell-substance along the line of the bands.

*Lagena annectens* must not be confounded with *L. lucida*, Williamson. The general contour of the shells differs considerably, *L. annectens* being more robustly built. Moreover, the "milky white" horseshoe-shaped bands in *L. lucida* occupy a much greater relative proportion of the shell surface, and the internal tube, so strikingly apparent in *L. lucida*, is hardly, if at all, developed in any of our specimens of *L. annectens*, recent or fossil.

*Occurrence.*—The 'Challenger' specimens were obtained off Kerguelen Island (20 to 120 fathoms), and off Sydney (410 fathoms). Schlicht's specimens, described by Reuss, were from the Oligocene of Pietzpuhl. The Crag specimen is from Tattingstone, zone **d**.

22. Lagena Orbignyana (*Seguenza*), 1862. Plate VII, figs. 13 *a*, *b*.

Entosolenia marginata (pars), *Williamson*, 1858. Rec. Foram. Gt. Brit., p. 9, pl. i, figs. 19, 20.

Fissurina Orbignyana, *Seguenza*, 1862. Foram. Monotal. Messin., p. 66, pl. ii, figs. 25, 26.

— Romettensis, *Idem*, 1862. Ibid., fig. 24.

— Gemellarii, *Idem*, 1862. Ibid., p. 70, pl. ii, fig. 45.

Lagena tricincta, *Gümbel*, 1868. Abhandl. k. Bayer. Akad. Wiss., vol. x, p. 606, pl. i, figs. 8 *a*, *b*.

Fissurina marginata, var. tricarinata, *Reuss*, 1870. Sitzungsb. k. Akad. Wiss. Wien, vol. lxii, p. 468, No. 19 *a*.

Lagena, No. 63, *Schlicht*, 1870. Pietzpuhl, p. 11, pl. iv, figs. 1—3 (ectosolenian form).

Fissurina tricincta, *Terquem*, 1882. Mém. Soc. Géol. France, ser. 3, vol. ii, Mém. 3, p. 30, pl. i (ix), figs. 19 *a*, *b*.

— tricarinata, *Idem*, 1882. Ibid., p. 32, pl. i (ix), figs. 25—28.

Lagena marginata, var. Orbignyana, *Wright*, 1882. Proc. Belfast Nat. Field Club, App. vi, p. 181, pl. viii, fig. 5.

Fissurina marginata, *Terquem*, 1882. Mém. Soc. Géol. Fr., ser. 3, vol. ii, Mém. 3, p. 30, pl. i (ix), figs. 20—22.

Lagena Orbignyana, *Brady*, 1884. Report 'Challenger,' pp. 447 and 484, pl. lix, figs. 1, 18, 24—26; winged variety, fig. 20.

— — *Balkwill and Millett*, 1884. Journ. Microscopy, vol. iii, p. 82, pl. iii, fig. 1.

— — *Brady, Parker, and Jones*, 1888. Trans. Zool. Soc., vol. xii, part 7, p. 222, pl. xliv, fig. 20.

— — *Egger*, 1893. Abhandl. k. Bayer. Ak. Wiss., vol. xviii, part 2, p. 333, pl. x, figs. 89—91.

— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 82.

*Characters.*—This close ally of *L. marginata* has three parallel keels, of which the central one is usually the widest.

*Occurrence.*—*Lagena Orbignyana* has a world-wide distribution and a very extensive bathymetrical range; but it is less frequently found in high latitudes. The species was first described by Seguenza from the Miocene of Messina. It has been recorded from the Eocene (Calcaire Grossier) of the Paris Basin, the Oligocene of Pietzpuhl, the Pliocene of Piedmont and St. Erth, and the Post-Tertiary beds of Ireland. We have found specimens also in the Scaldisian of Antwerp. In the Coralline Crag we have found it sparingly in nearly all the zones examined.

23. Lagena lacunata, sp. nov., *Burrows and Holland*. Plate VII, figs. 12 *a*, *b*.

Lagena castrensis, *Brady* (non *Schwager*), 1884. Report 'Challenger,' vol. ix, p. 485, pl. lx, figs. 1—3 ?

— — *Balkwill and Wright* (non *Schwager*), 1885. Trans. R. I. Acad., vol. xxviii (Sci.), p. 341, pl. xii, figs. 20, 21.

*Characters.*—Test compressed, nearly circular, tapering slightly towards the oral end, periphery tricarinate; body of test biconvex; ornamented externally with shallow pittings irregularly disposed; aperture ectosolenian and fissural.

This is a modification of *L. Orbignyana* (Seguenza), and is distinguished from *L. castrensis*, Schwager, with which it has been confounded by the authors mentioned above, by the substitution of shallow pittings for exogenous beads. Brady, in the 'Challenger' Report, describes his specimens as ornamented with "large exogenous beads irregularly scattered over the lateral faces of the test." The figures in his pl. lx, however, show a surface ornamentation of shallow pittings. We have carefully examined the figured 'Challenger' specimens which are preserved in the British Museum, and we find that they agree with the plates, and not with the description in the text. We are confirmed in this view by Mr. Hollick, the artist who prepared the 'Challenger' plates from the actual specimens.

Messrs. Balkwill and Wright give no description of the specimens mentioned in their paper, but the figures in their pl. xii, which were also drawn by Mr. Hollick, clearly show pittings. Mr. Wright has kindly sent his specimens for our inspection, and we find that they exactly agree with our own examples of *L. lacunata*.

This species is approached by *Lagena* (*Entosolenia*) *variolata*, Schlumberger, and by *Lagena* (*Fissurina*) *punctata*, Seguenza; but the pittings upon both these species are relatively much smaller, and are arranged with marked regularity; whereas in *L. lacunata* the pittings are relatively large, few in number, irregular in outline, and irregularly disposed.

*Occurrence.*—In the recent condition *L. lacunata* appears to be somewhat rare. Dr. Brady's specimens were obtained from four 'Challenger' stations, namely, "off East Moncœur Island, Bass Strait, 38 fathoms; off Raine Island, Torres Strait, 155 fathoms; off Amboyna, 15 to 20 fathoms; and the *Hyalonema*-ground, south of Japan, 345 fathoms." It has also been found off the Irish coast, 45 to 50 fathoms.

In our own Collections we have fossil specimens from the Casterlian and Scaldisian formations at the Kattendyk Docks, Antwerp. In the Coralline Crag

we have found it somewhat commonly at Tattingstone, zone **d**; and also, but more rarely, at Sudbourne Hall and Broom Hill, zone **d**; at Sutton, zone **e**; and Gedgrave, zone **f**.

Mr. Wright, of Belfast, informs us that this species has been found also on the shore, at extreme low water, at Southport, Lancashire, as mentioned by Mr. G. W. Chaster, in the 'Report Southport Society Nat. Science' for 1890–91 (1892), p. 62 ("*L. castrensis*").

### *Sub-family* 2.—Nodosariinæ.

*Brady, Report 'Challenger,'* 1884, *pp.* 69 *and* 488.

*General Characters.*—Test polythalamous; straight, arcuate, or plano-spiral.

There are but few from among the numerous so-called genera and sub-genera of this family that have to be noticed here. Belonging to the type *Nodosaria* there are from the Crag only the following:

1. *Glandulina*, referred by some direct to *Nodosaria*.
2. *Nodosaria* (proper).
3. *Dentalina*, often regarded as *Nodosaria*.
4. *Vaginulina*.
5. *Marginulina*.
6. *Cristellaria*.

Ten figures of good examples of noticeable varieties have been added (in Pls. V, VI, and VII) to those noticed in Part I. The lists of synonyms have, of course, greatly increased since 1866.

The genus *Nodosarina* (Part I, 1866, p. 46), proposed by Parker and Jones in 1859, although scientifically applicable to the manifold series of subtypical forms which it was intended to comprise, has not been widely adopted; the appellations of the sub-types, such as *Glandulina*, *Nodosaria*, &c., being more readily and conveniently used in a *quasi*-generic sense. They all also fall into the recognised sub-family of "*Nodosariinæ*." For convenience, therefore, the terms *Glandulina*, *Nodosaria*, and others are used here as generic or subgeneric, as in many other memoirs and monographs. It is further most convenient to retain the use of the names of even subordinate sub-types, such as *Dentalina*, &c., as occasion seems to require, although their slight differential characters are not of real zoological value; but, just as with other Foraminifera, slight modifications serve to differentiate them artificially.

In the 'Ann. Mag. Nat. Hist.,' ser. 3, vol. iii, 1859, pp. 476, 477, *Nodosarina* was adopted by Parker and Jones (and by Carpenter, 'Introd. Foram.,' 1862, p. 156) as a broad generic term for the great group of hyaline Foraminifera

comprising *Nodosaria*, *Cristellaria*, and eight or more sub-genera, or so-called "genera;" by Jones, in the 'Monthly Microscop. Journ.,' vol. xv, 1876, p. 90, for fourteen sub-genera; and by H. B. Brady, in his 'Monograph of Carboniferous and Permian Foraminifera,' Pal. Soc., 1876, p. 122, for twelve and more sub-genera; but its use has not been found generally convenient. Dr. A. Goës, however, as an exponent of real biological relationship, in his highly valuable and physiological revision of accepted "genera" and "species," uses this term in his memoir "On the Reticularian Rhizopoda of the Caribbean Sea" ('Kongl. Svenska Vetenskaps-Akad. Handl.,' vol. xix, No. 4, 1882). Dr. A. Hosius also uses it as a generic term for seven forms in the 'Verhandl. Nat. Ver. Preuss.-Rhein.,' 1892, p. 152, &c.; it is also adopted by M. F. Bernard in his 'Élém. Paléont.,' part 1, 1893, p. 92.

*Genus*[1] 1.—GLANDULINA, *d'Orbigny*, 1826.

*Brady, Report 'Challenger,'* 1884, *pp.* 490—494.

Part I, 1866, p. 47.

*Additional Synonyms:*

GLANDULINA.—*Neugeboren, Costa, Fornasini, Stache, Terquem, Berthelin, Egger, Schwager, Dunikowski, Blake, Alth, Hantken, Roemer, Deecke, Quenstedt, Bronn, Bütschli, Schlumberger, Haeusler, Olszewski, Uhlig, Hitchcock, Karrer, Marsson, Dervieux, Guppy, and others.*

NODOSARIA.—*Reuss, Parker and Jones, Brady, Goës, de Amicis, and others.*

1. GLANDULINA LÆVIGATA, *d'Orbigny*, 1826. Plate I, figs. 1—3.

Part 1, 1866, p. 47, No. 1; Appendix II, Table, No. 35.

*Additional Synonyms:*

Cornu Hammonis erectum globosius, *Plancus*, 1739. Conch. minus notis, &c., p. 16, pl. ii, figs. 3, D, E, F; and edit. 2, 1760, p. 19, pl. ii, figs. D, E, F.

Nuclei, &c., *Soldani*, 1780. Saggio Orittogr., p. 107, pl. v, fig. 39, T?

Orthocerata unilocularia, &c., *Idem*, 1780. Ibid., p. 108, pl. vi, fig. 45, O; pl. vii, figs. 45, V, X, and 46, A (?).

Testæ *Cordiformes, Soldani*, 1791. Testaceogr., vol. i, part 2, p. 92, pl. xcvi, fig. z?

Orthoceras *cordiforme læve, Idem*, 1791. Ibid., p. 98, pl. civ, fig. D.

[1] *Quasi*-generic only.

Polymorpha *Subovalia, Soldani*, 1791. Ibid., vol. i, part 2, p. 115, pl. cxvii, fig. *r*.

— *Sphærulæ vitreæ læves, Soldani*, 1791. Ibid., vol. i, part 2, p. 115, pl. cxviii, fig. E.

Testæ oviformes, glandiformes, &c., *Soldani*, 1798. Ibid., vol. ii, p. 17, pl. iii, figs. *dd, hh, ii* (?).

— ovales, oliviformes, pyriformes, fusiformes, &c., *Soldani*, 1798. Ibid., vol. ii, p. 37, pl. xii, fig. I.

Glandulina inflata, *Costa*, 1838. Fauna Reg. Nap., p. 14, pl. iv, fig. 1.

— lævigata, *Reuss*, 1846. In Geinitz Grundr. Verst., p. 651, pl. xxiv, fig. 1.

Nodosaria (Glandulina) lævigata, *Reuss*, 1846. Ibid., p. 652, pl. xxiv, fig. 5.

Glandulina Haidingerina, *Neugeboren*, 1850. Verh. Mitth. Siebenburg Ver. Nat., vol. i, p. 48, pl. i, fig. 2.

— lævigata, *Bronn*, 1856? Leth. Geogn., edit. 3, vol. iii, p. 242, pl. cccliii, figs. 3 *a, b*.

— — *Neugeboren*, 1856. Denksch. k. Akad. Wiss. Wien, vol. xii, part 2, p. 67, pl. i, figs. 3, 4.

— inflata, *Costa*, 1856. Pal. Reg. Nap., p. 126, pl. xi, fig. 21.

— acuminata, *Costa*, 1856. Ibid., p. 125, pl. xi, fig. 19.

Nodosaria (Glandulina) lævigata, *Parker and Jones*, 1857. Ann. Mag. Nat. Hist., ser. 2, vol. xix, p. 280, pl. x, figs. 6—8, and 9, var.

Glandulina lævigata, *Carpenter, Parker, and Jones*, 1862. Introd. Foram., pl. xii, fig. 5.

Nodosaria (Glandulina) lævigata, *Parker and Jones*, 1863. Ann. Mag. Nat. Hist., ser. 3, vol. xii, p. 439.

Glandulina lævigata, *Brady*, 1864. Trans. Linn. Soc., vol. xxiv, p. 468, pl. xlviii, fig. 7.

Nodosaria (Glandulina) lævigata, *Parker and Jones*, 1865. Phil. Trans., vol. clv, p. 340, pl. xiii, fig. 1.

Glandulina lævigata, *Jones, Parker, and Brady*, 1866. Monogr. Foram. Crag, p. 47, pl. i, figs. 1—3.

— — (typica), *Reuss*, 1870. Sitz. Akad. Wiss. Wien, vol. lxii, pp. 477, 478; *Schlicht*, Pietzpuhl, 1870, Nos. 85, 86, pl. vi, figs. 7, 8.

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— Lævigata, *Brady and Robertson*, 1870. Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 295.

— — *Parker, Jones, and Brady*, 1871. Ann. Mag. Nat. Hist., ser. 4, vol. viii, p. 153, pl. ix, fig. 34.

— — *Hantken* (1876), 1881. Mitth. Jahrb. k. Ungar. Geol. Anstalt, vol. iv, p. 40, pl. iv, fig. 7.

— — *Schwager*, 1877. Boll. R. Comm. Geol. Ital., vol. viii, p. 25, pl. o, fig. 6.

— — *Terquem*, 1878. Mém. Soc. Géol. France, ser. 3, vol. i, p. 12, pl. i (vi), fig. 3.

Glandulina lævigata, *Bütschli*, 1880. In Bronn's Klassen, &c., p. 197, pl. vii, fig. 25.

— — *Schlumberger*, 1882. Feuil. Jeune Nat., part 1, fig. 6.

— — *Jones*, 1883. Microgr. Dict., ed. 4, p. 357, pl. xxiii, figs. 28 *a*, *b*.

— elongata, *Schwager*, 1883. Palæontographica, vol. xxx, p. 107, pl. iii, fig. 7.

— lævigata, var. inflata, *Andreae*, 1884. Abh. geol. Specialkarte Elsass-Loth., p. 206, pl. vii, fig. 12.

— — *Idem.*, 1884. Ibid., p. 206, pl. x, fig. 22.

Nodosaria (Glandulina) lævigata, *Brady*, 1884. Report 'Challenger,' p. 490, pl. lxi, figs. 17—22, 32, including varieties. (Figs. 20—22, *typica*.)

Glandulina lævigata, *Gümbel*, 1885. Geol. Bayern, vol. i, part 2, p. 421, fig. 2664.

Nodosaria (Glandulina) abbreviata, *Sherborn and Chapman*, 1886. Journ. Roy. Micr. Soc., p. 746, pl. xiv, fig. 20.

Glandulina lævigata, *Haeusler*, 1887. N. Jahrb. for 1887, part 1, p. 189, pl. v, figs. 29, 30.

Nodosaria (Glandulina) lævigata, *Burrows, Sherborn, and Bailey*, 1890. Journ. Roy. Micros. Soc., p. 556, pl. ix, figs. 14, 15.

Glandulina lævigata, *Crick and Sherborn*, 1891. Journ. Northamp. Nat. Hist. Soc., vol. vi, p. 209, pl. vi, fig. 4.

— — *Egger*, 1893. Abhandl. k. Bayer. Akad. Wiss., vol. xviii, part 2, pp. 336 and 339, pl. xi, fig. 31.

Nodosaria lævigata, *de Amicis*, 1893. Boll. Soc. Geol. Ital., vol. xii, fasc. 3, pp. 353 and 470.

— — *Dervieux*, 1894. Boll. Soc. Geol. Ital., vol. xii, fasc. 4, p. 597, pl. v, figs. 1, 2.

— — *Goës*, 1894. K. Svensk. Vet.-Akad. Handl., vol. xxv, No. 9, p. 71, pl. xiii, figs. 702, 703, 706, 707, 709.

Glandulina cuspidata, *Franzenau*, 1894. Glasnik Hrvatskoga Naravoslovnoga Društva (Proc. Soc. Hist.-Nat. Croatica), p. 259, pl. v, fig. 5.

Nodosaria (Glandulina) lævigata, *de Amicis*, 1895. Nat. Sicil., vol. xiv, p. 21.

*Characters.*—Few-chambered, compact, short, ovate with pointed base, or more or less fusiform; transverse section circular; aperture terminal and central.

Besides the recognised *Gl. lævigata*, d'Orb., Brady gives (Report 'Challenger,' pp. 490—494) particulars of numerous varieties and sub-varieties of this sub-typical form.

*Occurrence.*—*Glandulina lævigata* has a very wide range in recent seas, both as regards latitude and depth of water. It is specially abundant in the northern

portion of the North Atlantic (at 50 to 1360 fathoms). The greatest depth at which it has been found is 1375 fathoms, in the Southern Ocean.

As a fossil its first recorded appearance is from the Lias[1] of Leicestershire (?); it has also been found in the Oxford Clay of Leighton Buzzard; the Kimmeridge Clay of Aylesbury; the Gault of Folkestone; the Red Chalk of Speeton; the Upper Chalk of Keady Hill, Ireland; the London Clay (Eocene); the Oligocene of Elsass; the Miocene of Vienna, Italy, and Muddy Creek, Victoria; the Pliocene of Garrucha (South Spain), Italy, and St. Erth. In the Coralline Crag it has been found at Sutton only.

### *Genus* 2.—Nodosaria, *Lamarck*, 1816.

*Brady, Report 'Challenger,'* 1884, *pp.* 69 *and* 488.

Part I, 1866, p. 48.

*Additional Synonyms:*

Nautilus.—*Martini.*
Encorycium.—*Ehrenberg.*
Nodosarina.—*Parker and Jones.*
Frondicularia, pars.—*Berthelin.*
Nodosaria.—*Cuvier, Bowdich, Ansted, Mantell, Eley, Silvestri, Hantken, Schwager, Olszewski, Sherborn, Chapman, Gümbel, Mariani, Zwingli and Kübler, Fric, Andreae, Gemmellaro, Suess, Zittel, Schlumberger, Bütschli, Prestwich, Reeve, Terrigi, Pictet, Fornasini, Franzenau, Boll, Buvignier, Schmid, Marsson, Cornuel, Basset, Goës, Agassiz, Hamilton, Malagoli, Richter, Dunikowski, Rouault, Deecke, Toutkowsky, Howchin, Steinmann, Hartwig, Mackie, Nicholson, Hoernes, Balkwill, Wright, Smedley, Beudant, Geinitz, Hagenow, Blake, Pilla, Uhlig, Hitchcock, Chimmo, Haeusler, Koenen, Quenstedt, Seguenza, Dervieux, de Amicis, Millett, Guppy, and others.*

*General Characters.*—Chambers, few or many, in linear succession; cylindrical or tapering; more or less septate; smooth or ornamented; aperture terminal, central, often produced. Straight forms = *Nodosaria;* arcuate forms = *Dentalina.*

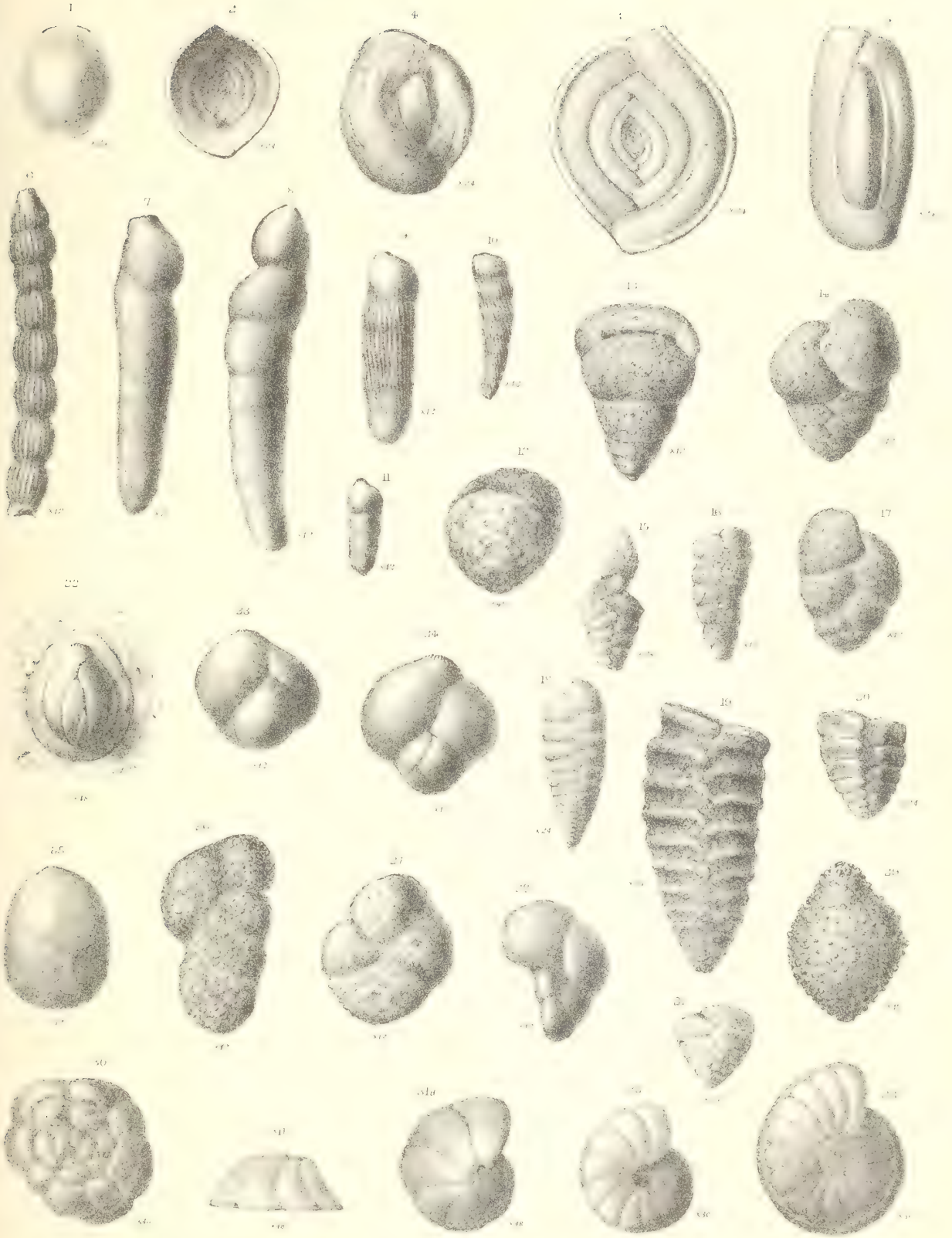
[1] See the foot-note at page 161 regarding the Liassic specimens formerly supposed to have come from the Trias of Chellaston.

## PLATE V.

Fig.

1. *Biloculina depressa*, d'Orb. × 24.
2. *Spiroloculina excavata*, d'Orb. × 24.
3. — *nitida*, d'Orb., Variety. × 24.
4. *Miliolina circularis* (Bornemann). × 24. Mr. F. Chapman's Collection.
5. — *oblonga* (Montagu). × 24. Mr. F. Chapman's Collection.
6. *Nodosaria obliqua* (Linné). × 12.
7. *Vaginulina linearis* (Montagu). × 12.
8. — *lævigata*, Römer. × 12.
9. — *obliquestriata*, sp. nov., J. × 12.
10. — — — × 12.
11. — — — × 12.
12. *Haplophragmium glomeratum* (?), Brady. × 48. Mr. F. Chapman's Collection.
13. *Textilaria gibbosa*, d'Orb. × 12.
14. — — — × 12.
15. — *sagittula*, Defrance, Variety. × 24.
16. — — — × 12.
17. — *tuberosa*, d'Orb. × 12.
18. — *sagittula*, Defrance. × 24.
19. — *jugosa*, Brady. × 24.
20. — *sulcata*, sp. nov., J. × 24.
21. — *subflabelliformis*, Hantken. × 24.
22. *Polymorphina concava*, Williamson. × 48. Mr. F. W. Millett's Collection.
23. — *problema*, d'Orb. × 12.
24. — *communis*, d'Orb. × 12.
25. — *turgida*, Reuss. × 12.
26. — *compressa*, d'Orb. (encrusted). × 12.
27. — *variata*, Jones, Parker, and Brady. × 12.
28. — *compressa*, d'Orb., Variety. × 12.
29. — *tuberculata*, d'Orb. × 48. Mr. F. Chapman's Collection.
30. *Planorbulina Mediterranensis*, d'Orb. × 48.
31. *Truncatulina refulgens* (Montfort). × 48. Mr. F. Chapman's Collection.
32. *Nonionina umbilicatula* (Montagu). × 36. Mr. F. Chapman's Collection.
33. *Operculina ammonoïdes* (Gronovius), Var. *curvicamerata*, nov., J. × 36. Mr. F. Chapman's Collection.

Excepting Figs. 4, 5, 12, 22, 29, 31, 32, 33, the specimens here figured are from the Searles-Wood Collection in the British Museum. All from the Coralline Crag.



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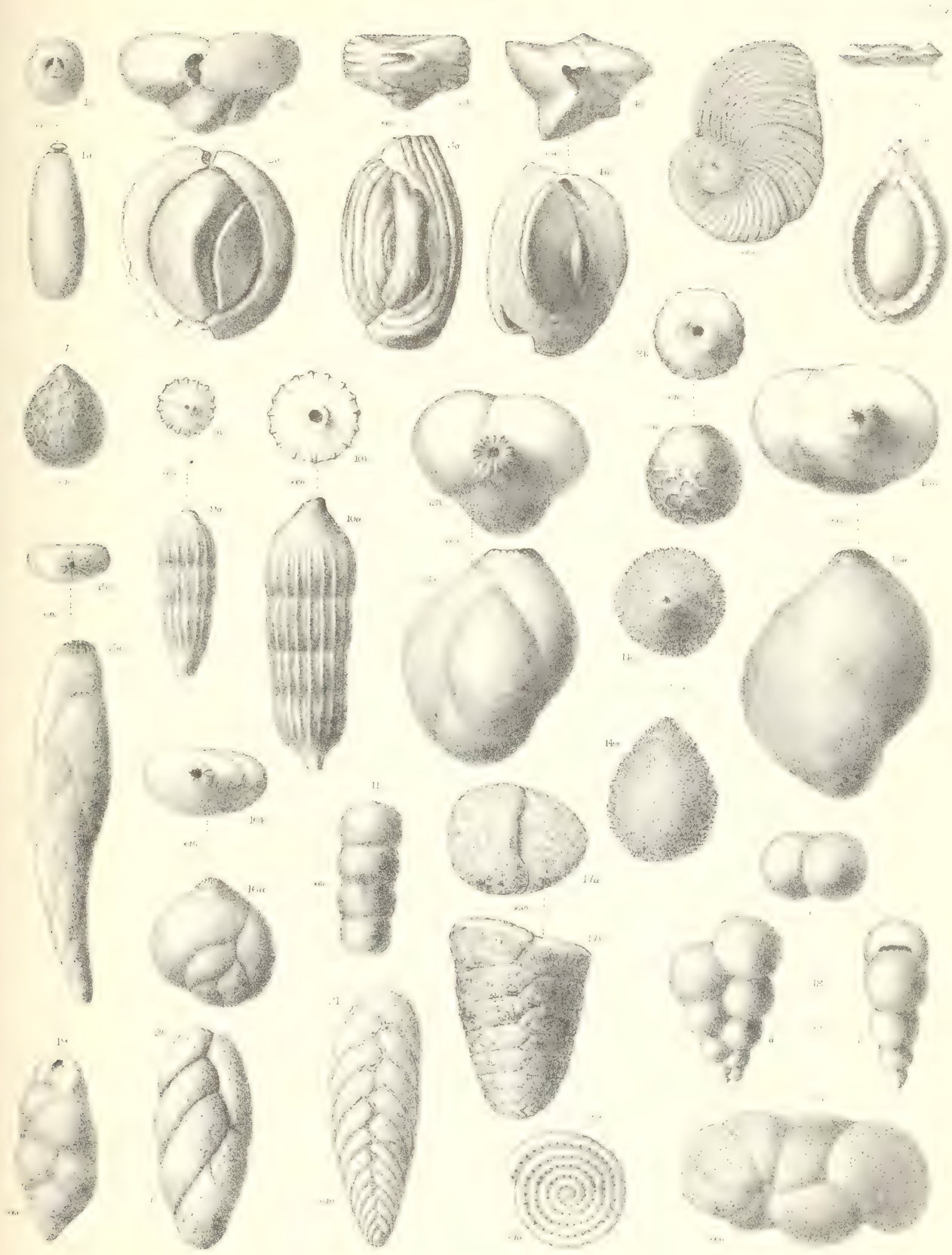
FORAMINIFERA OF THE CRAG.

## PLATE VI.

Fig.

1 *a*, *b*. *Biloculina elongata*, d'Orb. × 12. Cor. Crag, Sudbourne Hall.
2 *a*, *b*. *Miliolina triangularis* (d'Orb.). × 30. Cor. Crag, Sudbourne Hall.
3 *a*, *b*. — *pulchella* (d'Orb.). × 60. Cor. Crag, Broom Hill.
4 *a*, *b*. — *Cuvieriana* (d'Orb.). × 36. Cor. Crag, Gomer (Gedgrave).
5. *Peneroplis planatus* (F. and M.). × 60. Cor. Crag, Broom Hill.
6 *a*, *b*. *Lagena formosa*, Schwager. × 60. Cor. Crag, Broom Hill.
7. — *hexagona*, Williamson. × 70. Cor. Crag, Sudbourne Hall.
8 *a*, *b*. — *seminuda*, Brady. × 70. Cor. Crag, Sudbourne Hall.
9 *a*, *b*. *Nodosaria raphanus* (Linné). × 60. Cor. Crag, Sudbourne Hall.
10 *a*, *b*. — — — × 60. Cor. Crag, Sudbourne Hall.
11. — *ambigua*, Neugeboren. × 60. Cor. Crag, Sudbourne Hall.
12 *a*, *b*. *Polymorphina problema*, d'Orb., × 60. Cor. Crag, Sudbourne Hall.
13 *a*, *b*. — *sororia*, Reuss. × 60. Cor. Crag, Broom Hill.
14 *a*, *b*. — *hirsuta*, Brady, Parker, and Jones. × 60. Cor. Crag, Broom Hill.
15 *a*, *b*. — *cylindroïdes*, Römer. × 30. Cor. Crag, Broom Hill.
16 *a*, *b*. — *communis*, d'Orb. × 15. Cor. Crag, Broom Hill.
17 *a*, *b*. *Textilaria agglutinans*, d'Orb., Var. *densa*, nov., J. × 30. Cor. Crag, Broom Hill.
18 *a*, *b*, *c*. — *globulosa*, Ehrenberg. × 75. Chillesford Sand, Aldeby.
19. *Bulimina elegans*, d'Orb., Variety. × 60. Cor. Crag, Sudbourne Hall.
20. *Virgulina Schreibersiana*, Czjzek, Var. *obesa*, nov., J. × 15. Cor. Crag, Sudbourne Hall.
21. *Bolivina Ænariensis* (Costa). × 70. Cor. Crag, Sudbourne Hall.
22. *Spirillina vivipara*, Ehrenberg, Var. *unilinearis*, nov., J. × 70. Cor. Crag, Broom Hill.
23. *Truncatulina variabilis*, d'Orb. × 60. Cor. Crag, Broom Hill.

Excepting Fig. 4 (in Mr. F. W. Millett's Collection), the specimens figured in this Plate are in the Collections of Mr. H. W. Burrows and Mr. R. Holland, who kindly communicated the drawings. All except Fig. 18 are from the Coralline Crag.



H.W.Burrows }
R.Holland } del. ad nat.

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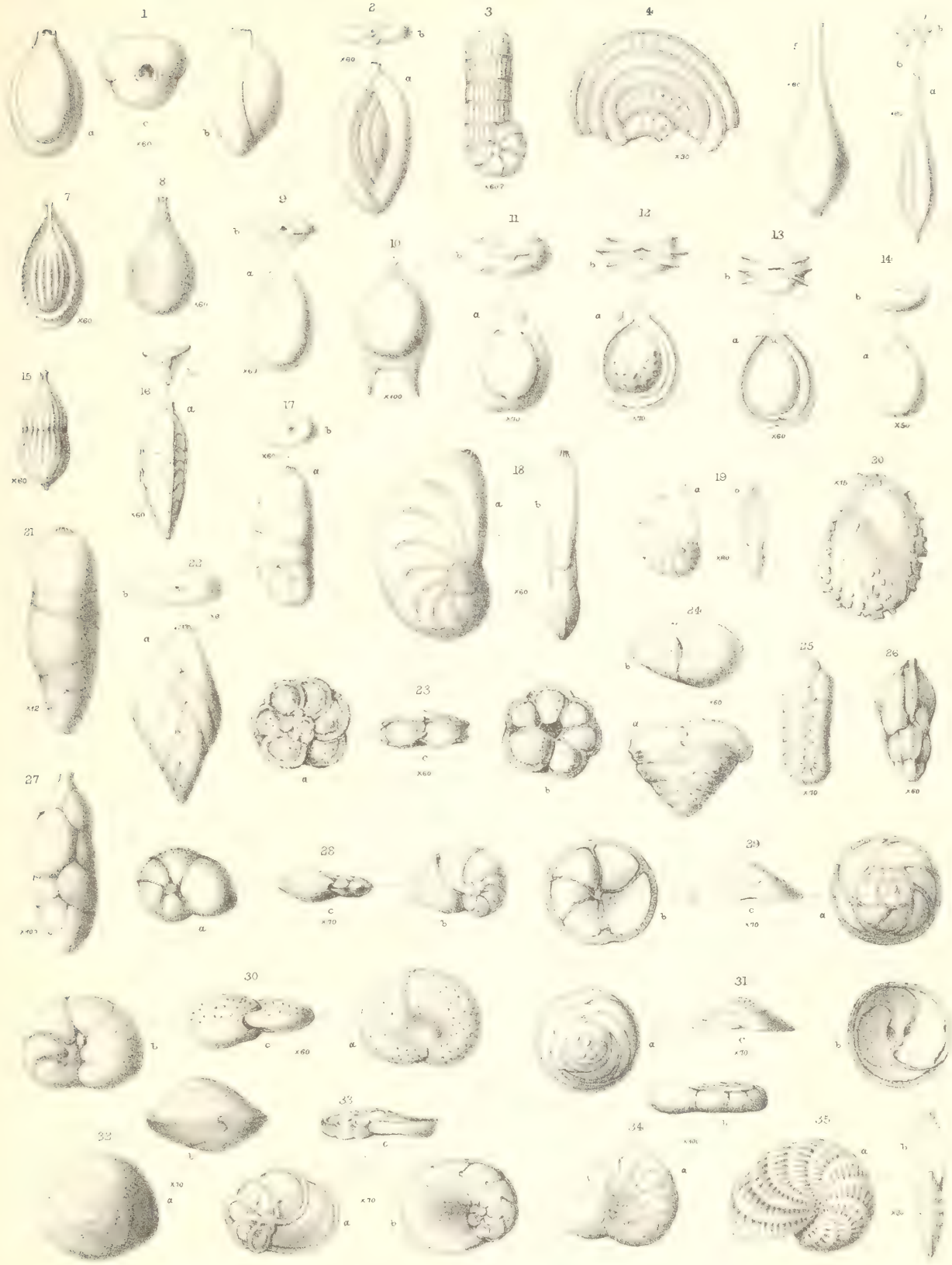
FORAMINIFERA OF THE CRAG

# PLATE VII.

Fig.

1 *a*, *b*, *c*. *Biloculina inornata*, d'Orb. × 60. Sutton.
2 *a*, *b*. *Sigmoilina tenuis* (Czjzek). × 60. Sutton.
3. *Peneroplis cylindraceus* (Lamarck). × 60 ? Sudbourne.
4. *Orbiculina adunca* (F. and M.). × 30. Sutton.
5. *Lagena clavata*, d'Orb. × 60. Sutton.
6 *a*, *b*. — *gracilis*, Williamson. × 60. Tattingstone.
7. — *formosa*, Schwager, Var. *comata*, Brady. × 60. Sutton.
8. — *striata*, d'Orb. × 60. Sutton.
9 *a*, *b*. *Lagena quadrata*, Williamson, Variety. × 60. Broom Hill.
10. — *seminiformis*, Schwager. × 100. Broom Hill.
11 *a*, *b*. — *annectens*, sp. nov., Burrows and Holland. × 70. Tattingstone.
12 *a*, *b*. — *lacunata*, sp. nov., Burrows and Holland. × 70. Tattingstone.
13 *a*, *b*. — *Orbignyana* (Seguenza). × 60. Tattingstone.
14 *a*, *b*. — *lævigata* (Reuss). × 60. Tattingstone.
15. *Nodosaria proxima*, Silvestri. × 60. Gedgrave.
16 *a*, *b*. *Rhabdogonium tricarinatum*, Reuss. × 60. Sutton.
17 *a*, *b*. *Dimorphina compacta*, B., P., & J. × 70. Gedgrave.
18 *a*, *b*. *Cristellaria reniformis*, d'Orb. × 60. Sutton.
19 *a*, *b*. — *gibba*, d'Orb. × 60. Sutton.
20. *Polymorphina frondiformis*, S. V. Wood, Var. *brevis*, nov., J. × 15. Gedgrave.
21. *Dimorphina tuberosa*, d'Orb. × 12. Sutton.
22 *a*, *b*. *Polymorphina complanata*, d'Orb. × 60. Sudbourne Hall.
23 *a*, *b*, *c*. *Globigerina Linnæana* (d'Orb.). × 60. Sudbourne Hall.
24 *a*, *b*. *Textilaria conica*, d'Orb. × 60. Sudbourne Hall.
25. *Spiroplecta rosula*, Ehrenberg. × 70. Gedgrave.
26. *Uvigerina angulosa*, Williamson. × 60. Sudbourne Hall.
27. — *Canariensis*, d'Orb., Var. *farinosa*, Hantken. × 100. Tattingstone.
28 *a*, *b*, *c*. *Discorbina globularis* (d'Orb.). × 70. Tattingstone.
29 *a*, *b*, *c*. — *turbo* (d'Orb.). × 70. Broom Hill.
30 *a*, *b*, *c*. *Anomalina grosserugosa*, Gümbel, Variety. × 60. Sudbourne Hall.
31 *a*, *b*, *c*. *Discorbina orbicularis* (Terquem). × 70. Sutton.
32 *a*, *b*. *Pulvinulina elegans* (d'Orb.). × 70. Sudbourne Hall.
33 *a*, *b*, *c*. *Discorbina lingulata*, sp. nov., Burrows and Holland. × 70. Sutton.
34 *a*, *b*. *Operculina ammonoïdes* (Gronovius). × 100. Gedgrave.
35 *a*, *b*. *Polystomella macella* (F. and M.). × 30. Broom Hill.

Excepting Fig. 3 (after a sketch by H. B. Brady), the figures in this Plate were drawn by Messrs. Burrows and Holland from specimens in their own Collections. All are from the Coralline Crag.



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FORAMINIFERA OF THE CRAG.

THE

# PALÆONTOGRAPHICAL SOCIETY.

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A MONOGRAPH

OF THE

# BRITISH JURASSIC GASTEROPODA.

BY

WILFRID H. HUDLESTON, M.A., F.R.S., F.L.S., V.P.G.S.

PART I, No. 8.

GASTEROPODA OF THE INFERIOR OOLITE.

Pages 391—444; Plates XXXIII—XL.

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## *Family*—PLEUROTOMARIIDÆ.

"*Shell nacreous, variable in form; whorls regular in their volutions, deflected or unrolled, but always exhibiting a special streak or* sinus-*band, constituted by the obliteration of a slit of the lip; this slit is generally permanent on the last whorl, but in some genera is partly closed, and the character of the perforation changed; aperture oval, rounded, or angular; lip thin; operculum circular, corneous, with a central nucleus.*"—Fischer.

In the Inferior Oolite of Britain two genera represent this family, viz. *Pleurotomaria* and *Trochotoma*.

### *Genus*—Pleurotomaria, *Defrance*, 1826.

"*Shell very variable; trochiform, turbinate, discoidal, or globular, internally nacreous; last whorl furnished with a notch of greater or less length, slitting the lip, and elsewhere prolonged by an obliterated band, bordered by one or two elevated lines; the growth-lines of the whorls above and below converge towards this band with posterior inclination; the striæ of the* sinus-*band are slightly curved and convex on the side of the spire; aperture oval or subrhomboidal; lip thin; operculum corneous, subspiral, or multispiral.*"—Fischer.

As far as the Jurassic rocks of this country are concerned, the genus *Pleurotomaria* seems to have reached its maximum development in those districts of the Inferior Oolite which are characterised by a Cephalopod facies. But its distribution is singularly unequal. Thus in the Dorset-Somerset district nearly all the beds, especially those towards the base of the Upper Division which more especially represent the "Oolithe ferrugineuse" of Normandy, abound with the fossilised remains of *Pleurotomariæ*, often in an excellent state of preservation. Dundry must be included in this category. In the Inferior Oolite of the Cotteswolds *Pleurotomariæ* are fairly numerous, but badly preserved, and consequently of very little use to the palæontologist. In the East Midland district the genus is sparingly represented, being almost entirely confined to the Northampton Sand and the lower beds of the Lincolnshire Limestone. From the rich shell-beds of Weldon and Great Ponton, believed to be in the upper part of the latter formation, *Pleurotomaria* is almost entirely absent or represented by dwarfed forms.[1]

[1] *Pl. reticulata*, Deslong. (*Pl. subreticulata*, d'Orb.), is doubtfully quoted by Morris from Ponton.

The various zones of the Inferior Oolite in Yorkshire are almost equally destitute of *Pleurotomariæ*, a very few specimens of a large form, related to the Liassic species, *Pl. Anglica*, being found in the lower portion of the Dogger.

Our collections, therefore, have received the bulk of their supplies from the Inferior Oolite of Dorset-Somerset, including Dundry. Most of the species recorded from these beds bear more or less resemblance to those already so well described and figured by Deslongchamps and d'Orbigny. Consequently it is proposed, in some cases, to deal rather briefly with the descriptions in the text. One of the points of interest which I have been able to elucidate relates to the distribution of the particular species in the Dorset beds. It is also clear that the several "species" have a tendency to run into each other, and thus gradually to merge or to become something requiring a different diagnosis. In no other group of the Gasteropoda has the lesson been enforced upon me more strongly that the mere enumeration of named forms, which we regard as species, is inadequate to convey a complete idea of the actual facts.

As regards the sections or groups into which the Inferior Oolite *Pleurotomariæ* most naturally fall, opinions may to a certain extent differ. Again reverting to the two principal authors who have dealt with the subject, we perceive in the pages of Deslongchamps a systematic arrangement applied to the entire Jurassic *Pleurotomariæ* of Normandy, whilst d'Orbigny appears to have made very little attempt at classification in any respect. Deslongchamps' treatment of the subject was much the most philosophic, and although he lived before the days when the doctrine of Evolution had been revealed to mankind, it is evident that he had some inkling of it. On the other hand, if ever there was a man who thoroughly believed in species, especially of his own creation or rectification, that man was the author of the 'Terrains Jurassiques.' His method undoubtedly has its merits, and the rigidity of his species is convenient for the collector.

In submitting the following grouping, which does not differ very widely from that adopted by Deslongchamps, I must again express my belief that sections, groups, and species must be regarded merely as means to an end, viz. the presentation of certain palæontological facts in what seems to be the most natural form. That there is a certain amount of inconvenience in appending a long string of varieties to certain "species" I admit, and some would, perhaps, prefer the more rigid d'Orbignian method; but if this is adopted the number of species would be greatly increased.

*Section* 1.—Conicæ.

Shells conical-elongate, not umbilicate, or having a very slight umbilical pit. Spire regular or concave. Whorls numerous; the body-whorl not exceeding one-third the total height, and often much less. Sinus-band rather narrow, often elevated, always anterior.[1] Aperture oblique, depressed, and nearly always showing a notch or fold at the columellar extremity.

*Pleurotomaria punctata*, Sowerby.
— *bicingulata*, sp. nov.
— *elongata*, Sowerby (typical form).
— var. *angusta*.
— — *conoidea*, Deshayes.
— — *Ebrayana*, d'Orb.
— — *turrita*, Deslong.
— *abbreviata*, Sowerby.
— *Agatha*, d'Orbigny.
— var. *Sandersii*, Tawney.
— *circumsulcata*, d'Orbigny.
— *subglabra*, sp. nov.
— *Bessina*, d'Orbigny.

It will be remembered that the greater part of this section, with the exception of the first two species, were included by Deslongchamps in his *Pleurotomaria mutabilis*.

*Section* 2.—Breves.

Shells small, conical, short; in most cases distinctly but not strongly umbilicate. Spire regular or inclining to convex; body-whorl seldom less than half the total height. Sinus-band submedian to anterior, and not very prominent. Aperture (except in *Pl. Dundriensis*) inclined to be subquadrate, strongly angled at the columnar extremity.

[1] The ornaments of the sinus-band in *Pleurotomaria* vary considerably even in different parts of the same specimen, and generally have a direct relation to the ornaments of the whorls.

*Pleurotomaria Dundriensis*, Tawney.
— *distinguenda*, Tawney.
— *scrobinula*, Deslongchamps.
— *Athulia*, d'Orbigny.
— *Alcyone*, d'Orbigny.

There is, perhaps, no sound palæontological basis for this section, which may include some incomplete forms more or less allied to species classed elsewhere.

*Section* 3.—Sulcatæ (*Leptomaria*, Eugène Deslongchamps, in part).

Shells small to middle-size, inclined to be heliciform, largely umbilicate. Spire variable, often very convex, apex more or less depressed. The whorls have the ornaments but slightly engraved, and are sometimes nearly smooth. Sinus-band narrow, usually without spiral lines, and often sunken. The slit of the inner lip extends some way back.

*Pleurotomaria sulcata*, Sowerby.
— — var. *obconica*, Tawney.
— *Ajax*, d'Orbigny.
— *monticulus*, Deslongchamps.
— *monticuloïdes*, sp. nov.
— *sulcata-Humphriesiana*, sp. nov.
— *Amyntas*, d'Orbigny.

*Section* 4.—Fasciatæ.

Shells conical, often of large habit, umbilicus moderate to *nil*. Whorls convex or subangular, sutures distinct; spiral ornament regular, but not very deeply incised, decussated in the earlier whorls (decussato-striated) with a tendency to smoothness in some cases. The sinus-band is almost exactly median and wide, usually presenting a flat strap-like appearance, although in the earlier whorls the spiral ornamentation may sometimes be noted.

*Pleurotomaria subplatyspira*, d'Orbigny.
— *fasciata*, Sowerby.
— *Stoddarti*, Tawney.
— *amata*, d'Orbigny.
— *transilis*, d'Orbigny.
— *Alimena*, d'Orbigny.

} *Fasciata*-group.

*Pleurotomaria phyospira*, Deslong.
— *subfasciata*, d'Orb. (*crenata*, Deslong.).
— cf. *subdecorata*, Münster.
— *Allica*, d'Orbigny.

*Sub-section.*—Whorls more angular, ornaments sometimes reticulate throughout; sinus-band situate at the angle, and rather less median.

*Pleurotomaria subreticulata*, d'Orbigny.
— *textilis*, Deslongchamps.

### *Section* 5.—Ornatæ.

Shells turrited, trochiform, turbinate or discoidal, with great range as to size; always umbilicate, often largely so. Whorls usually angular and carinated with sutures often canaliculate. The ornamentation is rich, with extensive and varied tuberculation on the carinæ. The sinus-band, except in *Pl. ornata*, Sow., is very wide, nearly median, flat or rarely projecting, and in the later whorls without much spiral striation.

*Pleurotomaria paucistriata*, d'Orbigny. } *Proteus*-group.
— *Proteus*, Deslongchamps. }
— *armata*, Münster.
— cf. *Sauzeana*, d'Orbigny.
— *tuberculosa*, Defrance. } *Ornata*-group.
— *ornata*, Sowerby. }
— *ornata-depressa*, sp. nov. }
— *Actæa*, d'Orbigny.
— *oxytera*, sp. nov.
— *Baugieri*, d'Orbigny.
— *actinomphala*, Deslongchamps.
— *Mopsa*, d'Orbigny.
— *mirabilis*, Deslong. (micromorphic variety).

*Sub-section.*—Shells turrited, attaining a great size, umbilicus small or *nil.* Whorls subtabulate with rich sculpture, and often much tuberculate ornament on the carinæ.

*Pleurotomaria subaraneosa*, sp. nov.
— cf. *araneosa*, Deslongchamps.

*Section* 6.—Granulatæ.

Shells trochiform, mostly inclined to be depressed, generally rather small, more or less umbilicate. Whorls sloping, flat or subangular; body-whorl relatively large, and usually with a very convex base. Ornaments for the most part deeply incised, so that cross-hatching produces a granular appearance. Sinus-band anterior, narrow and prominent, frequently constituting a keel.

*Pleurotomaria Yeovilensis*, Tawney.
— — var. *rugosior*.
— *granulata*, Sowerby.
— *phylax*, sp. nov.
— *plicopunctata*, Deslongchamps.
— *Palæmon*, d'Orbigny.
— *trapeza*, sp. nov.

In the above, *Pl. granulata*, *plicopunctata*, and *Palemon* constitute the *granulata*-group proper, which, be it remembered, was united with the *mutabilis*-group by Deslongchamps to form one section. Hence, according to the classification of that author, the Conicæ and the Granulatæ, as defined above, should for the most part be united. This constitutes the principal difference between the arrangement now adopted and the divisions in the 'Mémoire sur les Pleurotomaires.'

333. Pleurotomaria punctata, *Sowerby*, 1818. Plate XXXIII, figs. 1 and 2.

1818. Trochus punctatus, *Sowerby*. Min. Conch., pl. cxciii, figs. 1 and 4.
1850. Pleurotomaria punctata, *Sow.* D'Orbigny, Prod. i, p. 267.
1854. — — *d'Orbigny*. Terr. Jur., vol. ii, p. 513, pl. cccxcix, figs. 11—13.
1854. — — *Sow.* Morris, Cat., p. 271.
1873. — — — Tawney, Dundry Gasteropoda, p. 38 (30).
Non — — — Goldfuss, Petref. Germ., pl. clxxxvi, fig. 6.

*Bibliography, &c.*—Sowerby's figure, from a Dundry specimen, is somewhat indifferent, but there is no doubt as to the identification, this being one of the three species of Inferior Oolite *Pleurotomariæ*, where the figured specimen is preserved in the "Sowerby Type Collection" at the British Museum. D'Orbigny's

figure (also from a Dundry specimen) is characteristic, though the aperture is not seen. The species does not appear to have been recognised by Deslongchamps in the Normandy beds. On the other hand, Tawney regarded it as one of the commonest species at Dundry. He suggested that *Pl. Allionta*, d'Orbigny, might be a synonym.

*Description :*

| | |
|---|---|
| Height . . . . . | 40 mm. |
| Basal diameter . . . . | 33 mm. |
| Spiral angle . . . . . | 48°. |

Shell acutely conical, not umbilicate. Spire perfectly regular. Whorls (ten to twelve) flat, with a close suture, and spiral lines of unequal strength; these are more or less granulated towards the posterior and anterior margins of each whorl; the almost invisible suture lies between the raised lines which carry the strongest granulations.

The sinus-band forms a salient belt on the sides of the whorls, and is situated some distance below the centre; it is full, round, and rather narrow, having in the apical whorls a central spiral line crossed by growth-lines, but in the later whorls the growth-lines alone are seen, and even these are often effaced. The body-whorl is angular at the periphery; the base has a flat marginal area, but is excavated towards the centre; it is spirally striated with slight radial decussation. Aperture subrhomboidal and extremely depressed.

In the smaller shells the columellar notch is very characteristic (Fig. 2), and even in the larger shells a modification of this feature may be detected. In very large forms (? *Pl. Allionta*) the notch is effete.

*Relations and Distribution.*—*Pl. punctata* is a well-defined species, somewhat remotely related to the *elongata*-group. Excellent specimens have been obtained from Dundry. Good specimens are also obtained from the *Murchisonæ*-zone of Coker, and inferior ones from the same horizon at Bradford Abbas. The *Concavus*-bed at Bradford Abbas furnishes us with a number of beautiful specimens. The above are all in the Lower Division.

In the *Humphriesianus*-zone of North Dorset typical specimens may occasionally be met with. There is a large specimen in my collection, said to come from the *Parkinsoni*-zone, which may possibly represent *Pl. Allionta*, d'Orb. In this case there is no trace of the columellar notch.

334. Pleurotomaria bicingulata, sp. nov. Plate XXXIII, fig. 3.

Cf. Pleurotomaria Mariæ, *d'Orbigny*. Terr. Jur., vol. ii, p. 430, pl. cccIvi, figs. 9—11 (= *Pl. decipiens*, var. *turrita*, Deslongchamps).

*Description :*

| | |
|---|---|
| Height | 37 mm. |
| Basal diameter | 31 mm. |
| Spiral angle | 48°. |

Shell acutely conical, not umbilicate. Spire regular to slightly concave. Whorls (eleven to twelve) flat; sutures close. The base of each whorl is marked by a slightly crenulated rim, which projects over the succeeding whorl, and in the more adult whorls becomes smooth; spiral lines, slightly decussated, constitute the general ornamentation.

The sinus-band is anterior and prominent in the later whorls, and the spiral ornament is almost effaced; a round and almost smooth belt, here and there marked by growth-lines, remains. This belt of the sinus-band and the basal rim together constitute a marked bicarination in the anterior half of the whorls. The body-whorl is narrow and angular at the periphery; base flat towards the margin, slightly excavated in the centre, spirally striated with faint decussation. Aperture subrhomboidal and depressed with a sharp columellar notch.

*Relations and Distribution.*—This form differs from *Pl. Mariæ* chiefly in having the basal carinæ rather more prominent than the sinus-band, whereas in the species from the Lias the prominence is represented as being equal; the spiral angle also is less concave. *Pl. bicingulata*, through the prominence of the sinus-band, is related to *Pl. punctata*, whilst the presence of a modified basal rim connects it with certain varieties of the *elongata*-group, such as *Pl. Pictaviensis*.

Typical specimens occur in the *Concavus*-bed, Bradford Abbas, where they seem to shade off into the narrow variety of *Pl. elongata*. In some specimens the whorls are so much undercut that the shell, if held with the point downwards, appears like a nest of funnels, one within the other.

335. Pleurotomaria elongata, *Sowerby*, 1818. (= *Pl. mutabilis*, Deslongchamps, *pars.*) Plate XXXIII, figs. 4, 5, 6, and 7; Plate XXXIV, fig. 8.

| | | | | |
|---|---|---|---|---|
| 1818. | Trochus elongatus, *Sowerby*. | | | Min. Conch., pl. cxciii, figs. 2 and 3. |
| 1854. | Pleurotomaria elongata, *Sowerby*. | | | Morris, Cat., p. 271. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 37 (29). |
| Syn. | — | mutabilis, *Deslongchamps*, vars. elongata, mutica, and ambigua. | | Mém. Soc. Linn. Norm., vol. viii ("Les Pleurotomaires"), p. 108, &c., pl. x, figs. 14 and 15; pl. xi, fig. 1. |

*Bibliography, &c.*—Since this is a group rather than a species, in the stricter acceptation of the term, it would be useless to attempt a full synonymy. Tawney included the following, with more or less doubt, under this heading, viz. *Pl. abbreviata*, Sowerby, *Pl. conoidea*, Deshayes, and *Pl. Ebrayana*, d'Orbigny. The above, together with other named forms, are doubtless connected, and may for the most part be regarded as varieties. Nevertheless Deslongchamps, who attached, little value to the spiral angle as a means for determining species in *Pleurotomaria* made his *Pl. mutabilis* a little too comprehensive. Since Sowerby originally recognised two species in this group, viz. *Pl. elongata* and *Pl. abbreviata*, I have concluded to follow his example.

It will be observed in the sequel that *Pl. elongata*, as thus limited, covers a considerable variety of forms according to the horizon, the lower beds usually presenting the narrower forms, although in the *Parkinsoni*-zone at Burton Bradstock and elsewhere are a number of small specimens, many of which may be allotted to *Pl. elongata* in a general sense.

*General Description.*—Shell conical-elongate, not umbilicated. Spire regular or slightly concave, the spiral angle ranging from about 40° to somewhat less than 50°. Whorls about twelve, excavated, and terminated by a basal rim which projects over each succeeding whorl and constitutes an important feature. This rim is crenulated in some cases, and subcrenulate to smooth in others, presenting considerable variety in its sculpture. The intercarinal spaces have rich spiral ornament, slightly reticulate in the earlier whorls, subgranulate in the later ones.

The sinus-band is very anterior, rather narrow, and but slightly prominent, usually presenting one median spiral cross-hatched by growth lines, but in some cases the ornamentation is more complex. The body-whorl is angular at the periphery, with a flat base which is not as a rule excavated; base spirally grooved;

aperture subquadrate and moderately depressed with a slight columellar notch, not always preserved.

Var. *angusta* (Fig. 4).

This represents a form which may be noted in the Lower Division of the Inferior Oolite, where the spiral angle does not exceed 40°, and in some cases, as in the *Opalinus*-zone at Drympton, is even less. The specimen figured is from Bradford Abbas (? *Murchisonæ*-zone). Another specimen (Fig. 5), from the *Concavus*-bed of Bradford Abbas, presents a wider spiral angle besides some difference of ornamentation.

Var. near to *Pl. conoidea*, Deshayes (Fig. 6).

1831. PLEUROTOMARIA CONOIDEA, *Deshayes.* Coq. caract., p. 181, pl. iv, fig. 4.

This is a variety with extremely rich sculpture; the spiral angle in some cases is slightly concave, whilst the sinus-band is very anterior and not at all prominent.[1] These forms occur at Mapperton, Louse Hill, and other places believed to be in the *Humphriesianus*-zone.

*Pleurotomaria elongata*, Sowerby. Type form (Fig. 7).

Cf. 1854. PLEUROTOMARIA PICTAVIENSIS, *d'Orbigny.* Terr. Jur., vol. ii, p. 510, pl. cccxcix, figs. 1—5.

— — MUTABILIS, var. AMBIGUA, *Deslongchamps.* Vol. cit., p. 113, pl. xi, fig. 1.

This is a robust form with spiral angle of about 50°. It more nearly approaches Sowerby's type (one of the three species-types preserved in the British Museum[2]) than any of the others. In this variety the sculpture is principally seen in the more apical whorls; the basal rim of the anterior whorls being thick, round, and nearly smooth, whilst the spiral striæ in the whorls themselves are less deeply incised. The sinus-band in the lower whorls is smooth and very anterior; striæ in the base indistinct. Aperture subquadrate and moderately depressed; traces of the columellar notch very slight.

Characteristic specimens occur abundantly at Dundry and in the *Sauzei*-bed (base of the *Humphriesianus*-zone) at Combe and Oborne. Some persons might be disposed to restrict the specific name, *elongata*, to this form.

[1] Mr. Wilson considers that *Pl. conoidea* should be regarded as a distinct species, as he attaches great importance to the want of prominence in the sinus-band.

[2] *Vide antea*, p. 396.

Var. *Ebrayana*, d'Orbigny. Not figured.

1854. PLEUROTOMARIA EBRAYANA, *d'Orbigny*. Terr. Jur., vol. ii, p. 483, pl. cccl.xxxvii.

We have only to imagine the typical *Pl. elongata*, Sow., sufficiently enlarged with a corresponding increase of smoothness in the anterior whorls, and we obtain these megalomorphs, which occur at Dundry and more especially in the *Sauzei*-bed at Combe and Oborne.

Var. *turrita*, Deslongchamps. (Plate XXXIV, fig. 8.)

1848. PLEUROTOMARIA MUTABILIS, var. TURRITA, *Deslongchamps*. Vol. cit., p. 115, pl. x, fig. 16.

A narrow-angled and strongly turrited variety; the right lip almost vertical, and prolonged into a well-marked gutter or notch; ornaments of the basal rim large and richly cut; sinus-band inconspicuous. This very rare form occurs in the *Parkinsoni*-zone of Bradford Abbas and Woolston. It is interesting to note that with the narrow form we again see a well-developed columellar notch.

*Relations*, &c., of *Pl. elongata* generally. Sufficient has been said as to relations under the head of "Bibliography, &c." Whilst narrow and peculiar forms occur, as we have seen, both in the lowest and highest beds of the Inferior Oolite, the typical *Pl. elongata* is especially characteristic of the *Humphriesianus*-zone.

336. PLEUROTOMARIA ABBREVIATA, *Sowerby*, 1818 (= *Pl. mutabilis*, Deslongchamps, pars). Plate XXXIII, figs. 8 and 9.

1818. TROCHUS ABBREVIATUS, *Sowerby*. Min. Conch., pl. cxciii, fig. 5.
1854. PLEUROTOMARIA ABBREVIATA, *Sowerby*. Morris, Cat., p. 271.
Syn. — MUTABILIS, *Deslongchamps*, vars. ABBREVIATA and CORRUGATA. Vol. cit., pp. 108, 109, pl. x, figs. 13 and 18.

*Bibliography, &c.*—Admitting that this is little more than a variety of the

preceding species, yet there seems to be a considerable jump between the narrow-angled (*elongata*) and the wide-angled (*abbreviata*) forms. Moreover, in this country *Pl. abbreviata* is confined to the *Humphriesianus*-zone, and more particularly to the *Sauzei*-bed or subzone. One of the figures given by d'Orbigny of *Pl. conoidea*, Deshayes (vol. cit., Pl. cccIxxxii, fig. 1), covers this form very fairly; but, as there can be no doubt that the specimens from Dundry and Oborne represent the form described by Sowerby as *Trochus abbreviatus*, if we are to recognise the species at all it should be under the name given by Sowerby.

*Description.*—The spiral angle is about 65°, and in some cases very slightly concave; but the form is usually that of a perfect cone, where the height and basal diameter are nearly equal, the latter being usually a little in excess. The ornamentation is rather stronger than in most varieties of *Pl. elongata*, but the character of the basal rim and sinus-band is, on the whole, pretty much the same, though possibly the nodules of the basal rim have a tendency to become rather more complex. The aperture is subquadrate, the columellar lip being only slightly oblique, whilst the terminal notch or gutter is barely indicated.

There is a variety of *Pl. abbreviata* (see fig. 9) analogous to that which is observed in the typical variety of *Pl. elongata*. Here the ornamentation has a tendency to become smoother, especially in the basal carinæ. When this is carried to excess in very large specimens, we obtain a wide-angled *Pl. Ebrayana*.

*Relations and Distribution.*—Highly ornamented specimens of *Pl. abbreviata* approach *Pl. circumsulcata*, but in that species the sulcus in the base is usually distinct, and where this fails, the concave spire of *Pl. circumsulcata* will serve to distinguish them. On the other hand, it approaches the *conoidea* var. of *Pl. elongata*.

*Pl. abbreviata* is abundant in the *Sauzei*-bed at Oborne, and possibly occurs on the same horizon at Dundry. In the *Parkinsoni*-zone of Burton Bradstock are some small forms, which may be allotted partly to this species and partly to *Pl. elongata*.

337. Pleurotomaria Agatha, *d'Orbigny*, 1850 (= *Pl. mutabilis*, Deslongchamps, pars.) Plate XXXIII, figs. 12 *a*, 12 *b*, and Plate XXXIV, fig. 6. Var. *Sandersii*, Tawney, Plate XXXIV, fig. 7. Var. unnamed, XXXIV, fig. 9.

1850. Pleurotomaria Agatha, *d'Orbigny*. Prod., i, p. 268.
1854. — — — Terr. Jur., vol. ii, p. 474, pl. cccIxxxiii, figs. 1—3.

1873. Pleurotomaria Agatha, *d'Orbigny*. Tawney, Dundry Gasteropoda, p. 40 (32).

Syn. — mutabilis, var. cœlata, *Deslongchamps*. Vol. cit., p. 109, pl. x, fig. 17.

*Bibliography, &c.*—It is through the figure rather than the description that English specimens are connected with the var. *cælata* of Deslongchamps. On the other hand, as pointed out by Tawney, d'Orbigny's figure more nearly resembles the var. *corrugata* than the var. *cælata* of Deslongchamps. The principal characters by which I recognise *Pl. Agatha* are (1) the nodular character of the carinæ, and (2) the coarse ornamentation of the intercarinal spaces.

*Description :*

| | |
|---|---|
| Height (full size) . . . . | 50 mm. |
| Basal diameter . . . . | 50 mm. |
| Spiral angle . . . . | 60°. |

Shell conical, thick, not umbilicated. The spire is slightly concave. The whorls are flat, but owing to the prominence of the carinæ in some cases appear to be concave. The suture is extremely close. In the more typical forms the carinæ are coarsely nodular, and the intercarinal groovings (spiral) are deep and coarsely decussated.

The sinus-band is narrow, flat, and inconspicuous, and situate very close to the basal rim or carina. The body-whorl is more or less angular at the periphery, the base varying from rather flat to subconvex with spiral striæ. The aperture is subdepressed, with an oblique inner lip and but slight trace of the columellar notch.

Var. *Sandersii*, Tawney.

1873. Pleurotomaria Sandersii, *Tawney*. Dundry Gasteropoda, p. 39 (31), pl. iii, fig. 1.

The indications, as noted by Tawney, are very much those of Deslongchamps' var. *cælata*. But the whorls and also the base are more convex. The sinus-band also is very sunken and flat.

The unique specimen on which this variety is founded comes from Dundry. It is in a highly crystalline condition, a circumstance which may partly account for the peculiarities of the sinus-band.

338. Pleurotomaria Obornensis, sp. nov. Plate XXXIV, fig. 9.

*Description:*

| | |
|---|---|
| Height . . . . . | 44 mm. |
| Basal diameter . . . . | 36 mm. |
| Spiral angle . . . . . | 52°. |

Shell conical, elongate, with a slightly concave spire. Number of whorls nine or ten, but slightly excavated and rather narrow, the body-whorl occupying about one-fifth of the entire height. Each whorl is terminated by a wide, flattened, and richly sculptured basal rim or border, slightly undercut by the succeeding whorl, the rest of the whorl being marked by subreticulate ornament, in which the spiral element predominates.

The sinus-band is anterior, but not markedly so, owing to the great width of the basal rim; it is rather narrow and fairly prominent, with one strong median spiral and the usual cross-hatchings. In the body-whorl all the ornaments, even those of the basal rim, become smooth, and the sinus-band is rounded, narrow, and prominent. Base nearly flat or with a very slight concavity, spirally striated, with some radial decussation. Aperture oblique and depressed. Other indications wanting.

*Relations and Distribution.*—The excessive flatness and great width of the basal rim serve to separate this elegant conical shell from members of the *elongata*-group generally. In the richness of its sculpturing it approaches *Pl. Agatha*, but presents important differences. Very rare in the *Sauzei*-bed (Marl with green grains) at Oborne.

339. Pleurotomaria circumsulcata, d'Orbigny, 1854 (= *Pl. mutabilis*, Deslongchamps, pars). Plate XXXIII, figs. 10 and 11; and Plate XXXIV, fig. 3.

1854. Pleurotomaria circumsulcata, *d'Orbigny*. Terr. Jur., vol. ii, p. 470, pl. cccLxxxi, figs. 6—10.

Syn. — mutabilis, *Deslongchamps*, var. circumsulcata. Vol. cit., p. 112, pl. xi, fig. 2.

The spiral angle is about 70°, and very distinctly concave. Unless the base is well exposed and in good preservation, the submarginal furrow which constitutes one of its peculiar features cannot be observed. The original figure by Deslongchamps

represents an acutely conical shell with a concave spiral angle and tuberculated carinæ. Hence the species seems to occupy a position between *Pl. abbreviata* and *Pl. Bessina*.

I have a small specimen (Pl. XXXIII, fig. 11), from the *Parkinsoni*-zone of Burton Bradstock, which plainly shows the submarginal furrow in the base. In this specimen the sinus-band is narrow and prominent; it corresponds precisely both in size and structural details with specimens from the *Parkinsoni*-zone of Bayeux, which are generally referred to *Pl. circumsulcata*. The other figured specimens, which are referred with some doubt to *Pl. circumsulcata*, correspond as regards spiral angle and general ornamentation, but they do not show a well-developed marginal furrow in the base.

340. Pleurotomaria subglabra, sp. nov. Plate XXXIV, figs. 1 and 2.

*Description:*

| | |
|---|---|
| Height | 48 mm. |
| Basal diameter | 55 mm. |
| Spiral angle (mean) | 68°. |

Shell acutely conical, scarcely umbilicate. Spire markedly concave. Full number of whorls about eleven; these are flat or only very slightly excavated, with a very close suture. The earlier whorls are terminated by a slight basal rim or carina, but in the later whorls this feature is almost effaced, although the spirals at the base have somewhat larger granulations where we should expect to find the basal carina; the rest of the whorl is ornamented with fine spiral striæ, more or less decussated, the striæ in some cases being so delicate that the shell becomes almost smooth.

The sinus-band is very anterior; it is narrow, and more prominent in the coarsely ornamented than in the finely ornamented specimens, but it is not, on the whole, a conspicuous feature. The body-whorl projects somewhat beyond the angle of the spire, the periphery being slightly rounded off; base flat to subconvex, with spiral striæ corresponding to those on the flanks of the shell. There is a small umbilical hollow, but no true umbilicus. Aperture subrhomboidal and oblique, with but a faint trace of the columellar notch.

*Relations and Distributions.*—The concave spire serves to remove *Pl. circumsulcata*, *Pl. subglabra*, and *Pl. Bessina* from *Pl. abbreviata*. Yet we may expect to find links in the chain. Thus *Pl. subglabra*, which is probably only a glabrous variety of *Pl. circumsulcata*, constitutes an intermediate stage between *Pl. abbreviata*

and the very wide-angled and concave forms which it is convenient to focus under *Pl. Bessina*.

*Pl. subglabra* is somewhat rare; the very smooth varieties come from the *Humphriesianus*-zone of the neighbourhood of Sherborne.

341. Pleurotomaria Bessina, *d'Orbigny*, 1854 (= *Pl. mutabilis*, Deslongchamps, pars). Plate XXXIV, figs. 4 and 5.

| | | | | |
|---|---|---|---|---|
| 1854. | Pleurotomaria Bessina, *d'Orbigny*. | | | Terr. Jur., vol. ii, p. 460, pl. ccclxxvi. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 41 (33). |
| Syn. | — | mutabilis, *Deslongchamps*, var. patula. | | Vol. cit., p. 111, pl. x, fig. 12. |

*Bibliography, &c.*—Dr. Wright first noticed this as a British species from Dundry (*vide* Tawney, loc. cit.). It will be observed that none of our specimens exhibit the submarginal line in the base, which is delineated in the "Terrains Jurassiques." Fortunately, Deslongchamps speaks of the "cordon marginal" as slightly marked or entirely disappearing; whilst his figure of the var. *patula* does not show a trace of it. Hence the absence of this feature in our English specimens need cause no apprehension.

*Description :*

| | |
|---|---|
| Height . . . . . | 50 mm. |
| Basal diameter . . . . | 70 mm. |
| Spiral angle . . . . . | 80°—85°. |

Shell acutely conical, scarcely umbilicated. Spire extremely concave ("comme un tort chinois"). Whorls about eight or nine, flat or but slightly excavated, with regular spiral striæ throughout. In the more typical form (fig. 4), which in England is rare, the basal rim is prominent and coarsely nodular. As a rule, in British specimens the basal rim is flattened and subnodular (fig. 5), whilst in all cases the basal rim of the body-whorl in the adult shell has a tendency to become smooth. Flanks richly sculptured.

The sinus-band varies with the age of the whorls, being on the whole narrow, raised, and close to the basal rim. The body-whorl largely projects beyond the angle of the spire, and in the adult whorl the sinus-band is slightly flattened; the ornaments are rather smoother than in the whorls of the spire. Base flat to subconvex, spirally striated, and with a small umbilical slit (not a true umbilicus). The aperture is subrhomboidal, oblique, and depressed, and the traces of the columellar notch seem entirely obliterated.

*Relations and Distribution.*—Closely related by its concave spire and general character to the two preceding species, *Pl. Bessina* and its numerous varieties represent the most wide-angled forms of the *mutabilis*-group. In this country it is essentially a fossil of the *Parkinsoni*-zone, and is not uncommon in that horizon at Halfway House.

342. Pleurotomaria Dundriensis, *Tawney*, 1873. Plate XXXIV, fig. 11.

1873. Pleurotomaria Dundriensis, *Tawney*. Dundry Gasteropoda, p. 46 (38), pl. iii, fig. 3.

*Description:*

| | |
|---|---|
| Height | 27 mm. |
| Basal diameter | 32 mm. |
| Spiral angle | 75°. |

Shell regularly conical and moderately umbilicated. Whorls (about seven) flat and close together, the anterior ones being slightly undercut owing to the development of a broad basal ring. The spiral ornamentation is strong throughout, with marked reticulation in the earlier whorls; the posterior half of the last two whorls is ornamented by thick oblique costæ, rather wide apart.

The sinus-band is submedian, of moderate width and salience, with a raised line in the centre (where this feature happens to be preserved). The body-whorl is relatively large, subangular at the periphery; the base is somewhat concave midway to the umbilicus, with strong spiral ornament radially decussated. Aperture rhomboidal and depressed, the inner lip very oblique.

*Relations and Distribution.*—In this species Tawney fancied that he traced a resemblance to *Pl. Mysis*, d'Orbigny, a Middle Lias fossil not hitherto identified in England. Indirectly *Pl. Dundriensis* is connected with the *Fasciata*-group. Rare at Dundry, and only doubtfully identified elsewhere. Not, perhaps, a very satisfactory species.

343. Pleurotomaria distinguenda, *Tawney*, 1873. Plate XXXIV, fig. 10, and Plate XXXV, fig. 1.

1873. Pleurotomaria distinguenda, *Tawney*. Dundry Gasteropoda, p. 45 (37), pl. iii, fig. 2.

*Description:*

| | |
|---|---|
| Height | 18 mm. |
| Basal diameter | 20 mm. |
| Spiral angle | 70°. |

The following is the original diagnosis:—"Shell conical, regular; whorls straight-sided, ornamented with rows of separate tubercles, placed obliquely in opposite directions on either side of the sinus-band. Above the band are three rows of compressed tubercles; below it are three of smaller round tubercles, and then three to four larger ones which form the angle in the last whorl [*vide* Pl. XXXV, fig. 1]. Sinus-band [submedian] with a central salient ridge, and crossed by curved lines; base of last whorl slightly convex. The umbilicus was probably closed."

*Relations and Distribution.*—Tawney was at some pains to point out how the ornaments of this species differ from those of *Pl. punctata*. However, the almost median position of the sinus-band would seem altogether to remove it from the section to which *Pl. punctata* belongs. The peculiar Dundry matrix gives emphasis to the ornamentation on which the author largely based his specific characters.

It is met with sparingly at Dundry, and shells which most nearly approximate to this form occur in the *Sauzei*-bed, or subzone, at Oborne and Milborne Wick. These have no umbilicus, and the aperture is almost quadrate with a straight inner lip.

344. Pleurotomaria scrobinula, *Deslongchamps*, 1848. Plate XXXV, figs. 3 and 3 *a*, and ? fig. 2.

1848. Pleurotomaria scrobinula, *Deslongchamps*. Vol. cit., p. 60, pl. ix, fig. 4.
1854. — — — D'Orbigny, Terr. Jur., vol. ii, p. 501, pl. cccxciv, figs 4—6.

*Description:*

| | |
|---|---|
| Height | 20 mm. |
| Basal diameter | 20 mm. |
| Spiral angle | 60°—62°. |

Shell small, conical, scarcely umbilicated. Spire regular or very slightly convex. Whorls (about seven) flat or scarcely angulated, suture close; the ornaments consist of a tolerably uniform system of fine spirals which are more or less reticulate, the reticulation being best seen in the earlier whorls.

The sinus-band is almost median, of fair width and prominence, with ornaments which vary from a single spiral with cross-lines (see Pl. XXXV, fig. 3 *a*) to almost smooth. The body-whorl is relatively large and bluntly angular at the periphery; base rather flat with faint spiral striæ, and sometimes a very slight umbilical pit occurs. Aperture rhomboidal to square, the inner lip being straight and reflexed at the extremity so as to form a widish gutter.

*Relations and Distribution.*—The specimens referred to *Pl. scrobinula* occur for the most part in the *Parkinsoni*-zone, where they are by no means abundant. The one figured is from Woolston. The agreement with Deslongchamps' description is substantial, though he describes *Pl. scrobinula* as having a smooth base—a feature possibly due to wear.

Fig. 2 represents a specimen from the *Cadomensis*-bed, Clatcombe (top of the *Humphriesianus*-zone), where the spire is rather more convex and the whorls slightly undercut, and the sinus-band is broad and with little apparent ornament; there is no umbilicus whatever. This may be a variety of *Pl. scrobinula*, but the ornamentation is rather coarser. In fact, this shell seems to occupy a position between *Pl. Dundriensis* and *Pl. scrobinula*.

345. Pleurotomaria Alcyone, *d'Orbigny*, 1850. Plate XXXV, figs. 4, 4 *a*, 4 *b*.

1850. Pleurotomaria Alcyone, *d'Orbigny*. Prod., i, p. 268.
1854. — — — Terr. Jur., vol. ii, p. 488, pl. ccclxxxix, figs. 6—10.

*Description :*

| | |
|---|---|
| Height | 20 mm. |
| Basal diameter | 23 mm. |
| Spiral angle | 73°. |

Shell conical, trochiform, moderately umbilicate. Spire regular. Whorls (seven) subconvex, with a slight belt developed at the base of each. Spiral ornaments fine throughout, but strongly reticulate from oblique radii in the posterior area of the whorls.

The sinus-band is submedian, rather narrow, and slightly sunk; carries one central spiral crossed by growth-lines, is sometimes smooth. The body-whorl is angular at the periphery, subconvex, and has the ornamentation subdued, the base being almost smooth; umbilicus small and rather steep, with curved radii springing from the margin. Aperture subrhomboidal and depressed.

*Relations and Distribution.*—The figured specimen, from the *Parkinsoni*-zone of Burton Bradstock, answers well to the description and figures of *Pl. Alcyone* in the 'Terrains Jurassiques.' It is rare.

346. Pleurotomaria Athulia, *d'Orbigny*, 1850. Plate XXXIV, fig. 12.

1850. Pleurotomaria Athulia, *d'Orbigny*. Prod., i, p. 269.
1854. — — — Terr. Jur., vol. ii, p. 489, pl. ccclxxxix, figs. 11—16.

*Description :*

| | |
|---|---|
| Height | 13 mm. |
| Basal diameter | 18 mm. |
| Spiral angle | 84°. |

A single specimen from Crewkerne station (? *Parkinsoni*-zone) corresponds well with the description in the "Terrains Jurassiques." The spire is very convex, and the ornaments similar. The peculiarity of the sinus-band, which is wide and placed in a groove towards the middle of the whorls, further helps the identification. In d'Orbigny's figure the base is somewhat fuller than in my specimen, and the aperture more oblique.

347. Pleurotomaria, species or variety. Plate XXXV, figs. 5 and 5 *a*.

*Description :*

| | |
|---|---|
| Height | 18 mm. |
| Basal diameter | 20 mm. |
| Spiral angle | 66°. |

Shell conical, not umbilicate. Spire regular, with apex slightly obtuse. Whorls (about seven) flat or scarcely convex, with close sutures, spirally striated, and with conspicuous radial ornamentation in the posterior areas. There is a small granulated belt at the base of each whorl.

The sinus-band is anterior, and situated in a slight groove. In the body-whorl, which is relatively large, the basal belt at the periphery becomes very conspicuous; base inclined to be flat, spirally striated and radially decussated, rising towards the columella. There is no umbilicus whatever. Aperture rhomboidal inclining to square, with a nearly straight inner lip.

Hitherto I have failed to identify this form, which differs from all the small conical species previously described in the anterior position of the sinus-band. A single specimen, believed to come from the *Parkinsoni*-zone of Burton Bradstock.

348. Pleurotomaria (*Leptomaria*) sulcata, *Sowerby*, 1818. Plate XXXV, figs. 6, 6 *a*, 6 *b*; and obconical variety figs. 7, 7 *a*, 7 *b*.

1818. Trochus sulcatus, *Sowerby* (Miller's MS.). Min. Conch., pl. ccxx, fig. 3.
1854. Pleurotomaria sulcata, *Sowerby*. Morris, Cat., p. 272.
1873. — — — Tawney, Dundry Gasteropoda, p. 43 (35).

*Bibliography, &c.*—Sowerby's type is at the Bristol Museum, and in all respects corresponds with the specimen now figured. The specimen in the collection of Sowerby's types at the British Museum seems to represent a somewhat narrow variety of *Pl. unisulcata*, d'Orbigny. As pointed out by Tawney, the whorls of Sowerby's species are convex but not angular. This may be gathered both from the description and figure in the 'Mineral Conchology.' The entire section (*Leptomaria*) of which *Pl. sulcata* may be regarded as the type-species, as developed in the Inferior Oolite, presents a series of forms which run into each other. Moreover, in such slightly sculptured shells what little ornament there may have been is often modified by fossilisation, whilst the spiral angle varies so much that it almost ceases to be a guide. Hence the division into "species" is attended with unusual difficulty.

*Description:*

| | |
|---|---|
| Height . . . . . | 22 mm. |
| Basal diameter . . . . | 32 mm. |
| Spiral angle (convex) . . . . | 95°. |

Shell heliciform and largely umbilicated. Spire convex, with an obtuse apex. The spire-whorls (about six) are narrow, convex or scarcely angulated, and separated by a suture, which in the early stages is somewhat canaliculate. The ornaments are faintly impressed, and vary much; specimens from Dundry generally show radial furrows in the upper part of the whorls, whilst the visible spiral ornamentation is chiefly anterior. Specimens from the *Murchisonæ*-zone of Burton Bradstock exhibit spiral striæ on the spire-whorls throughout, and this, in the apical portion, is reticulate, whilst the body-whorl is smooth, merely showing the growth-lines.

The sinus-band is antero-mesial and very narrow, being situated on the most prominent part of the whorl; it is usually countersunk and smooth. The body-whorl is relatively large and smooth, the flexuous growth-lines constituting the only ornament; these are continued in the rounded base to the edge of the wide and deep umbilicus. Aperture subovate and oblique.

Obconical variety (figs. 7, 7 *a*, 7 *b*).

Cf. Pleurotomaria obconica, *Tawney*. Dundry Gasteropoda, p. 45 (37), pl. iii, fig. 6.

Cf. also Pleurotomaria lævigata, *Deslongchamps*. Vol. cit., p. 138, pl. xvii, fig. 7.

The general outline is that of a blunt cone, the spire being convex and the spiral angle ranging from 80° to 85°. Most of the specimens which I have

referred to this form further differ from the typical *Pl. sulcata* in having the sutures rather more canaliculate and the umbilicus narrower and deeper; on the whole, too, the shells have less ornament. In most of my specimens the sinus-band is flat or countersunk, and the body-whorl relatively very large.

This is to all appearance an obconical variety of *Pl. sulcata*, though not exactly *Pl. obconica*, Tawney.

The figured specimen of Tawney's "*obconica*," which must of course be regarded as the type, has the whorls distinctly angular, as in *Pl. unisulcata*, d'Orb. But on the very same tablet (in the Bristol Museum) is an obconical specimen with rounded whorls, just like fig. 7 of the accompanying plate. It seems only reasonable to suppose that Tawney included such a form in his "*obconica*." Inferentially, therefore, this variety represents *Pl. obconica*, Tawney, although the figured specimen is not exactly the same.

*Relations and Distribution.*—In Dorset *Pl. sulcata* and the obconical variety just described are essentially fossils of the *Murchisonæ*-zone, being especially abundant at Coker and the Irony Nodule-bed at Burton Bradstock; rarer at Bradford Abbas and Stoford. The exact horizon at Dundry is not known to me, although there is good reason to believe that it is in the *Murchisonæ*-zone.

This species, in common with many other Inferior Oolite *Pleurotomariæ*, probably occurs in the Cotteswolds. Most specimens there are in the form of casts; hence the exact species is not easy to determine.

349. Pleurotomaria (*Leptomaria*) Ajax, *d'Orbigny*, 1850. Plate XXXV, figs. 8, 8 *a*, 8 *b*; and obconical variety, figs. 9, 9 *a*.

1850. Pleurotomaria Ajax, *d'Orbigny*. Prod., i, p. 268.
1854. — — — Terr. Jur., vol. ii, p. 484, pl. cccIxxxviii, figs. 1—5.

*Description:*

| | |
|---|---|
| Height | 15 mm. |
| Basal diameter | 23 mm. |
| Spiral angle (convex) | 100°. |

Shell heliciform, with a narrow umbilicus. Spire convex and depressed, apex very obtuse. Whorls (about six) narrow, tumid, and regularly marked with fine spiral striæ; these are very faintly cross-hatched in the earlier whorls, otherwise there is no axial ornamentation; sutures canaliculate.

The sinus-band is narrow and sunken, marked with fine lines or plain; in the

earlier whorls its position is so anterior as to be almost concealed. The body-whorl is relatively large, convex, and rounded off at the basal periphery, the whole being ornamented with regular spiral striæ up to the edge of the umbilicus; in this portion of the shell the sinus-band is about two-thirds down. Aperture subdepressed and oblique.

*Obconical Variety* (fig. 9).—This presents certain analogies with the variety described under the preceding species. Usually specimens run rather larger than in the more depressed and typical form of *Pl. Ajax;* spiral angle in some cases as low as 80°, always obtuse. The sinus-band is less concealed in the earlier whorls, and also more prominent and striated. There are also other differences.

*Relations and Distribution.—Pl. Ajax*, including the obconical variety, is rather abundant in the bottom bed of the Lincolnshire Limestone at Lincoln, which is in the *Murchisonæ*-zone. It seems to be a representative of *Pl. sulcata*, which occurs on the same horizon in the south-west; the chief difference lying in the regular and more deeply incised spiral ornamentation and the smaller umbilicus. There is a somewhat similar form in the Northampton Sand at Duston.

350. Pleurotomaria (*Leptomaria*) monticulus, *Deslongchamps*, 1848. Not figured.

| | | | | |
|---|---|---|---|---|
| 1848. | Pleurotomaria monticulus, *Deslongchamps*. | | | Vol. cit., p. 143, pl. xiii, figs. 5 *a—d*. |
| 1854. | — | — | — | ? D'Orbigny, Terr. Jur., vol. ii, p. 485, pl. cccIxxxviii, figs. 6—10. |
| 1873. | — | — | — | ? Tawney, Dundry Gasteropoda, p. 44 (36). |

The specimen on which Tawney based this identification has more resemblance to *Pl. Agathis*, Desl. Lately, however, Mr. Wilson has found a specimen at Dundry, which, though rather small, may be safely identified with *Pl. monticulus*.

351. Pleurotomaria monticuloides, sp. nov. Plate XXXV, figs. 10, 10 *a*.

*Description :*

| | |
|---|---|
| Height | 27 mm. |
| Basal diameter | 29 mm. |
| Spiral angle (subconvex) | 70°. |

Shell conoidal, moderately umbilicate. Spire subconvex, apex rather obtuse.

Whorls (about seven) flat to slightly convex, sutures rather close and not canaliculate. Spiral ornamentation is faintly inscribed thoughout the apical whorls, but in the later whorls it is only seen in the anterior areas; traces of radial ornamentation slight.

The sinus-band is narrow and inconspicuous; it is nearly mesial, or only slightly anterior. The body-whorl occupies about half the height of the shell, and is bluntly angular towards the base, which is rather flat with faint spiral striæ. Indications respecting the umbilicus not very clear; aperture nearly square.

*Relations and Distribution.*—The conoidal figure, almost flat whorls, and non-canaliculate sutures serve to distinguish this form from *Pl. monticulus*, which it otherwise greatly resembles. Rare on a low horizon at Haselbury and Coker.

352. Pleurotomaria (*Leptomaria*) sulcata-Humphriesiana, sp. nov. Plate XXXV, fig. 11.

N.B.—It is not without much hesitation that I venture in this case to make a new species. The form now under consideration occupies a position midway between—

Pleurotomaria Agathis, *Deslongchamps*. Vol. cit., p. 139, pl. xiii, fig. 8,
and
— sulcata, *Deshayes* after *Sowerby*. Deslongchamps, vol. cit., p. 135, pl. xiii, fig. 4 = *Pl. unisulcata*, d'Orbigny.

*Description:*

| | |
|---|---|
| Height . . . . . | 24 mm. |
| Basal diameter . . . . | 31 mm. |
| Spiral angle . . . . . | 80°. |

Shell conical, largely and deeply umbilicate. Spire almost regular, with a subacute apex. Whorls (seven) slightly convex, and with rather faint spiral ornament, often decussated posteriorly by sinuous growth-lines. There are two varieties, one where the suture is slightly canaliculate and the whorls subangular, another where the whorls are rather undercut. In some specimens the radial ornament on the posterior area of the whorls is strong.

The sinus-band is very narrow, and situate slightly below the middle of the whorls, and in the subangular variety occupies the prominence. The body-whorl is bluntly angular at the periphery; base scarcely convex, smooth, or only marked with faint radial striæ. Umbilicus steep and "staircase-like." Aperture nearly square, inner lip straight and rather thickened, being slightly removed on the columella.

*Relations and Distribution.*—The oblique and sinuous radial ornamentation in the upper part of the whorls resembles that which characterises both *Pl. sulcata* and *Pl. Agathis*. But the conical outline and sharper apex distinguish it from both these species. The general form is undoubtedly near to *Pl. unisulcata*, though somewhat too uniformly conical, and the whorls not sufficiently angular.

I have six specimens from the *Humphriesianus*-zone of Louse Hill and Oborne. The exact locality of the figured specimen is unknown (? Louse Hill). The form may be regarded as representing *Pl. sulcata*, Sow., on a higher horizon, and very nearly equivalent to *Pl. unisulcata*, d'Orb.

353. Pleurotomaria (? *Leptomaria*) Amyntas, *d'Orbigny*, 1850. Plate XXXV, fig. 12.

| | | | | |
|---|---|---|---|---|
| 1850. | Pleurotomaria Amyntas, *d'Orbigny*. | | | Prod., i, p. 268. |
| 1854. | — | — | — | Terr. Jur., vol. ii, p. 495, pl. cccxcii, figs. 6—10. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 41 (33). |

*Description:*

| | |
|---|---|
| Height . . . . . | 44 mm. |
| Basal diameter . . . . | 44 mm. |
| Spiral angle . . . . . | 55°. |

Shell smooth, conical, subelongate, with a deep but narrow umbilicus. Spire regular and sharp, with the apex rather flattened. Number of whorls about nine in fully-developed specimens, though eight is more usual; these are subangular and moderately convex. The ornaments are usually very fine; in well-preserved specimens it is seen that the spiral striæ in the apical whorls are crossed by fine axial lines, so as to be subreticulate; later, the spiral ornamentation becomes feeble; the body-whorl in most specimens is nearly smooth, though in some (such as the one figured) the spiral ornaments are still visible.

The slit is narrow, and extends backwards about a quarter of the circumference of the body-whorl. The sinus-band is narrow and smooth, being situate on the angular prominence of each whorl, so as to constitute a slight keel about two-thirds the way down. The body-whorl is usually smooth and bluntly angular at the basal periphery, the base flat, and glabrous or substriated; umbilicus funnel-shaped. Aperture suboval.

*Relations and Distribution.*—This fine and often glabrous shell has affinities with the typical *Leptomariæ* through its narrow sinus or slit; whilst the size and

shape of the spire and, to a certain extent, the ornamentation connect it with the *Fasciatæ*.

It is abundant and characteristic in the Irony Nodule-bed (*Murchisonæ*-zone) at Burton Bradstock. A smaller and more glabrous variety occurs in the *Concavus*-bed at Bradford Abbas. Tawney quotes it from Dundry. All my specimens indicate a fossil of the Lower Division.

354. Pleurotomaria subplatyspira, *d'Orbigny*, 1850. Plate XXXVI, fig. 1.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria subplatyspira, *d'Orbigny*. | | Prod., i, p. 269. |
| 1854. | — | — | Terr. Jur., vol. ii, p. 496, pl. cccxciii, figs. 1—3. |
| Syn. | — | fasciata, var. platyspira, *Deslongchamps*. | Vol. cit., p. 54, pl. vi, fig. 2. |

*Bibliography, &c.*—This and the three following species constitute the *Fasciata*-group (*Gyrocycla*, Deslong., *pars*).

*Description.*—A somewhat imperfect specimen from the *Sauzei*-bed, Milborne Wick, is about 44 mm. in height and width, with a spiral angle, slightly convex, of 64°. Shell umbilicate, rather obtuse at the apex. Whorls (nine) slightly convex; spirally striated in the anterior areas only, except in the extreme apical whorls, where the ornaments are reticulate, as is usually the case with *Pleurotomariæ* belonging to this section; sutures distinct, but not deeply impressed. The sinus-band is broad and slightly raised, showing but little trace of striæ or growth-lines, even in the earlier whorls; it is flat and strap-like in the later ones, and antero-mesial in position. The body-whorl is almost devoid of ornamentation.

This specimen is slightly wider than the types of Deslongchamps and d'Orbigny. The broad submesial sinus-band at once separates it from *Pl. Amyntas* and the whole of the "narrow-slit" section.

355. Pleurotomaria fasciata, *Sowerby*, 1818. Plate XXXVI, fig. 3.

| | | | |
|---|---|---|---|
| 1818. | Trochus fasciatus, *Sowerby*. | | Min. Conch., pl. ccxx, fig. 1. |
| 1854. | Pleurotomaria fasciata, *Sowerby*. | | Morris, Cat., p. 271. |
| 1873. | — | — | Tawney, Dundry Gasteropoda, p. 51 (43). |

*Bibliography, &c.*—*Pleurotomaria fasciata* represents a group rather than a species, since forms which may fairly be classed as varieties are numerous. Indeed, the exact Dundry type is not often met with elsewhere. Deslongchamps (vol. cit., p. 53) expressed a suspicion that his var. *platyspira* was possibly identical with *Trochus fasciatus*, Sow., but I have followed d'Orbigny in regarding them as distinct. The following description of *Pl. fasciata* is based on Dundry specimens.

*Description:*

| | |
|---|---|
| Height . . . . . | 65 mm. |
| Basal diameter . . . . | 67 mm. |
| Spiral angle . . . . . | 66°. |

Shell conical, moderately umbilicate. Spire rather obtuse towards the apex, otherwise nearly regular. Whorls (about nine) of moderate and regular convexity, and ornamented throughout by a complete system of rather fine spirals which in the earlier whorls are decussated so as to produce a reticulate pattern; sutures very distinct, but not deeply impressed.

The sinus-band occupies the crown of the convexity in each whorl, and is broad and almost median in position, being rather salient in the earlier whorls, flat and strap-like in the later ones; the ornaments are composed of two or more spirals with the usual cross-hatching, but in the later whorls these are generally worn smooth. The body-whorl is full, subangular at the periphery, and spirally striated both in the flank and base, in addition to growth-lines radiating from the margin of the narrow funnel-shaped umbilicus. Aperture subquadrate to oval.

*Relations and Distribution.*—The "Gyrocyclas" and, to a certain extent, the "Gyroplatas" of Deslongchamps are more or less related to *Pl. fasciata*, which may be accepted as a general term where specimens do not admit of any close differentiation.

This species has a wide distribution throughout the Inferior Oolite in this country. The finest specimens known to me are from Dundry, the matrix being the Iron-shot Oolite, which is probably in the *Humphriesianus*-zone. Both the typical form and the variety *platyspira* occur rarely in the *Sauzei*-bed at Oborne. In the Cotteswolds it is found chiefly in the form of casts. I have a specimen from the *Murchisonæ*-zone of Coker. It is by far the most abundant species of *Pleurotomaria* in the Northampton Sand at Duston, where individual specimens are nearly as fine as at Dundry. Small specimens of this species, resembling *Pl. Niortensis*, d'Orb., are not uncommon in the "Base-bed" at Lincoln (*Murchisonæ*-zone); subreticulate ornament is very conspicuous in the apical whorls of some of these.

356. Pleurotomaria Stoddarti, *Tawney*, 1873. Plate XXXVI, fig. 2.

1873. Pleurotomaria Stoddarti, *Tawney*. Dundry Gasteropoda, p. 50 (42), pl. iii, fig. 5.

*Description:*

| | |
|---|---|
| Height (full size) . . . . | 70 mm. |
| Basal diameter . . . . | 84 mm. |
| Spiral angle . . . . . | 75°. |

Shell conical, subacute, largely umbilicated. Spire regular. Whorls (nine) very convex, and curving each way towards the deep suture. The ornamentation consists of spiral lines and oblique decussating radial lines inclined, as usual, in opposite directions on either side of the sinus-band; the earlier whorls have a cancellated appearance, but in the later ones the area above the sinus-band is almost smooth from the absence of spiral lines and the faintness of the cross-hatching.

The sinus-band is broad and situated very slightly below the middle of the whorls; where these possess much ornament, it exhibits three spirals which are cross-hatched; in the later whorls it is flat and strap-like. The body-whorl is tumid and rounded at the periphery; base rounded, full, and almost smooth, or only marked by curved radii springing from the deep and funnel-shaped umbilicus. Apex subovate.

*Relations and Distribution.*—As an obvious member of the *Fasciata*-group this is most nearly related to *Pl. subplatyspira*, especially in the failure of ornament in the upper part of the whorls. But the wider spiral angle, convex whorls, and deep suture, serve to separate it. Viewed as a member of Deslongchamps' compound species, *Gyrocycla*, it most nearly approaches the var. *saccata*, but has a much wider spiral angle, besides other differences.

Apparently known only from Dundry, where the Iron-shot Oolite has yielded the Bristol Museum two fine specimens.

357. Pleurotomaria amata, *d'Orbigny*, 1854. Plate XLIV, figs. 11 *a*, 11 *b*, 11 *c*.

1854. Pleurotomaria amata, *d'Orbigny*. Terr. Jur., vol. ii, p. 512, pl. cccxcix, figs. 6—10.

The principal objection to this identification arises from the circumstance that d'Orbigny regarded his species as approaching *Pl. unisulcata*. This is certainly

not the case with the fossils now under consideration. Yet for these d'Orbigny's description and, to a certain extent, his figures answer exceedingly well.

The following may be taken as representing the dimensions of British specimens:

| | |
|---|---|
| Height . . . . . | 25 mm. |
| Basal diameter . . . . | 30 mm. |
| Spiral angle . . . . . | 72°. |

My specimens are somewhat smaller than the French ones, but the spiral angle, shape, and ornamentation are almost identical. If there is any difference, the whorls in d'Orbigny's figured specimen are rather more angular.

The specimens which I refer to *Pl. amata* occur principally at Louse Hill, in the upper part of the *Humphriesianus*-zone. They evidently belong to the Fasciatæ, though restricted in size as compared with the bulk of that section.

358. Pleurotomaria transilis, *d'Orbigny*, 1854. Plate XXXVI, figs. 4, 4 *a*.

1854. Pleurotomaria transilis, *d'Orbigny*. Terr. Jur., vol. ii, p. 482, pl. cccl.xxxvi.

Syn. — gyrocycla, var. transilis, *Deslongchamps*. Vol. cit., p. 60, pl. vii, fig. 1.

The specimen figured in the accompanying plate has a spiral angle of 58°, and is without umbilicus. On the whole it tallies fairly well with the figures and descriptions of the French authors, especially Deslongchamps, of this member of the *Gyrocycla*- or *Fasciata*-group. There are two specimens in my collection from the *Parkinsoni*-zone of Burton Bradstock.

359. Pleurotomaria Alimena, *d'Orbigny*, 1850. Not figured.

1850. Pleurotomaria Alimena, *d'Orbigny*. Prod., i, p. 268.

1854. — — — Terr. Jur., vol. ii, p. 462, pls. cccl.xxvii and cccl.xxviii, fig. 1.

Syn. — gyroplata, var. æquistriata, *Deslongchamps*. Vol. cit., p. 57, pl. vi, fig. 4.

Since it is probable that the varieties *æquistriata* and *inæquistriata* merely represent different stages or conditions of the same species, it might be permissible to retain the specific name *gyroplata*. Provisionally, however, we may accept d'Orbigny's name *Alimena*.

A specimen in my collection answering well to the description and figures, as quoted above, has a height of 80 mm. and a spiral angle of 50°. The shell is acutely conical, and scarcely umbilicated. The whorls are subconvex to flat, but well marked off by the suture. The body-whorl is angular at the basal periphery, and the base nearly flat. In the early whorls the ornaments are finely reticulate, becoming smooth in the adult stage. Sinus-band quite median, broad and very flat in the later whorls.

One specimen from the *Parkinsoni*-zone of Burton Bradstock.

360. Pleurotomaria subfasciata, *d'Orbigny*, 1850. Plate XLIV, fig. 10.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria subfasciata, *d'Orbigny*. | | Prod., i, p. 269. |
| 1854. | — | — — | Terr. Jur., vol. ii, p. 500, pl. cccxciv, figs. 1—3. |
| Syn. | — | fasciata, var. crenata, *Deslongchamps*. | Vol. cit., p. 53, pl. vi, fig. 1. |

This is so well marked a form as to present little difficulty in identification. A specimen, believed to have come from the *Humphriesianus*-zone of the neighbourhood of Sherborne, has a height of 75 mm. and a spiral angle of 62°. It differs from Normandy specimens, as described, in having no umbilicus. *Pl. subfasciata* (*crenata* is more descriptive) helps to connect the Fasciatæ with the still more numerous section of the Ornatæ.

361. Pleurotomaria phyospira, *d'Orbigny*, 1850. Not figured.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria phyospira, *d'Orbigny*. | | Prod., i, p. 269. |
| 1854. | — | — — | Terr. Jur., vol. ii, p. 502, pl. cccxcv. |
| Syn. | — | fasciata, var. phyospira, *Deslongchamps*. | Vol. cit., p. 53, pl. v, fig. 4. |

A large but somewhat imperfect specimen, nearly 100 mm. in height, from the *Humphriesianus*-zone of the neighbourhood of Sherborne may, without doubt, be referred to this very characteristic form. Mr. Wilson has also found this species in the Iron-shot Oolite of Dundry. The shell is conical and subturrited, the earlier whorls being angular and carinated, with nodular ornaments on the carinæ; the lower whorls are smooth and tumid, and in harmony with the gyrocycloid forms of the Fasciatæ. This species constitutes another link between the Fasciatæ and the Ornatæ.

362. Pleurotomaria subdecorata, *Münster*, 1844, Inferior Oolite variety. Plate XXXVI, fig. 10.

1844. Pleurotomaria subdecorata, *Münster*. Goldf., Petref., pl. clxxxv, fig. 3.
1854. — — — ? D'Orbigny, Terr. Jur., vol. ii, p. 445, pl. cccIxiv, figs. 1—6.
1873. — — — (? non *d'Orb.*) Tawney, Dundry Gasteropoda, p. 44 (36).

*Description:*

| | |
|---|---|
| Height . . . . . | 30 mm. |
| Basal diameter . . . . | 40 mm. |
| Spiral angle . . . . . | 80°. |

Shell turbinate, subturrited, widely umbilicate. Spire regular. Whorls (seven) subconvex and rather flattened posteriorly, sutures subcanaliculate in the later whorls. The ornamentation is regular throughout, consisting of well-cut and slightly undulating spirals, which show beautiful cancellation in the early whorls, and a certain amount of radial striping in the posterior area of the later ones.

The sinus-band is submedian, prominent, and moderately wide, but does not constitute an angle; it has spiral ornament similar to that of the whorls, though rather closer. The body-whorl is bluntly angular at the periphery; base subconvex and largely umbilicated with strong spiral and radial ornamentation. Aperture subrhomboidal.

*Relations and Distribution.*—Near to *Pl. subdecorata*, M., this form differs in having the whorls less angular; yet, on the whole, conforming to Goldfuss' rather than to d'Orbigny's description. It belongs to the Fasciatæ, though with a tendency towards the Ornatæ.

The figured specimen, from Dundry, is the only one of that size from the Inferior Oolite. A much smaller form, about 12 mm. in height, and with six whorls, occurs sparingly in the *Concavus*-bed at Bradford Abbas and in the "Base bed" at Lincoln. These specimens seem to be truly micromorphs of *Pl. subdecorata*, but are rather more turrited and with canaliculate sutures. At present we should not be justified in constituting a new species.

363. Pleurotomaria Allica, *d'Orbigny*, 1850. Plate XXXVI, figs. 5, 5 *a*.

| | | | | |
|---|---|---|---|---|
| 1850. | Pleurotomaria Allica, *d'Orbigny*. | | | Prod., i, p. 268. |
| 1854. | — | — | — | Terr. Jur., vol. ii, p. 490, pl. cccxc. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 42 (34). |

*Description :*

| | |
|---|---|
| Height (large specimen) . . . | 55 mm. |
| Basal diameter . . . . | 45 mm. |
| Spiral angle . . . . . | 48°—52°. |

Shell conical, elongate, not umbilicated. Spire regular. Whorls (about nine) flat to subconvex, and slightly projecting over each other. There is some difference of ornamentation between the apical and anterior whorls; generally the system may be described as consisting of rather wide-apart spirals above the sinus-band, with a stronger and more decussated pattern below, *i. e.* the anterior portion of each whorl is minutely cancellate down to the sutural margin.

The sinus-band is median or only slightly anterior, fairly prominent in the apical whorls, flattish and not very wide in the more advanced ones. The body-whorl is between one third and one half the total height, and bluntly angular at the periphery; base flat to subconvex, with distinct spiral ornament and no umbilicus. Aperture subquadrangular and moderately oblique, with a very thick columellar lip.

*Relations and Distribution.—Pl. Allica* must be regarded as a member of the *Fasciata*-group, having a narrow spiral angle and a comparatively small habit. Its relationship to *Pl. Alimena* is obvious.

Tawney mentions one specimen from Dundry; I have five from the Louse Hill beds, which are generally regarded as in the upper part of the *Humphriesianus*-zone.

364. Pleurotomaria subreticulata, *d'Orbigny*, 1850. Plate XXXVI, figs. 6, 6 *a*, and ? fig. 7.

| | | | | |
|---|---|---|---|---|
| 1850. | Pleurotomaria subreticulata, *d'Orbigny*. | | | Prod., i, p. 268. |
| 1854. | — | — | — | Terr. Jur., vol. ii, p. 494, pl. cccxcii, figs. 1—5. |
| 1873? | — | — | — | Tawney, Dundry Gasteropoda, p. 46 (38), pl. iii, fig. 7. |
| Syn. | — | reticulata, *Deslongchamps*. | | Vol. cit., p. 64, pl. ix, fig. 3. |

*Bibliography, &c.*—Deslongchamps had some doubt whether his *Pl.* "*reticulata*" was really distinct from *Pl. textilis*, which latter, likewise, was held to merge into *Pl.* "*scalaris*." It must be admitted that these three forms wait upon each other closely, and I am inclined to regard *Pl.* "*scalaris*" as merely a megalomorph of *Pl. textilis*. *Pl.* "*reticulata*" seems distinct, but as the specific name had already been appropriated, the species was re-named *subreticulata* by d'Orbigny.

*Description.* (N.B.—There are two forms or varieties of *Pl. subreticulata* in the Dorset beds. The following more particularly relates to the narrow, elongate variety from the *Humphriesianus*-zone—fig. 6 :)

| | |
|---|---|
| Height . . . . . | 36 mm. |
| Basal diameter . . . . | 28 mm. |
| Spiral angle . . . . . | 55°. |

Shell conical-elongate, not umbilicate. Spire regular, with a sharp apex. Whorls (nine or ten) flat to subangular, with a slight basal rim ; sutures rather close. The entire shell, including even the sinus-band, is finely and evenly reticulate.

The sinus-band, which has three spiral lines, is rather below the middle of the whorls, prominent but not very wide ; it forms a keel, and thus, in conjunction with the basal rim, causes the whorls to be slightly bicarinate. Body-whorl distinctly bicarinate, the upper keel being formed by the sinus-band ; sharply angular at the periphery, with a flat base. There is a slight umbilical fissure but no true umbilicus. Aperture almost square, with a straight inner lip.

This variety occurs at Louse Hill and Mapperton ; the former locality yields fossils of the *Humphriesianus*-zone. The precise horizon at Mapperton has not, to my knowledge, been exactly determined, but the Gasteropoda greatly resemble those from Louse Hill.

*Description* of a smaller variety from the *Parkinsoni*-zone :—Short, conical shells about 20 mm. in height, and with a spiral angle of 60°. These approach *Pl. distinguenda*, Tawney, but are more bicarinate, whilst the ornamentation is more reticulate than in that species. The aperture is very square, and the inner lip thickened and slightly recurved. I have four specimens from the bed distinguished as P. 1, Burton Bradstock.

*Relations and Distribution.*—*Pl. subreticulata*, besides its intimate relation with the species next described, is connected with a kind of sequence of reticulate *Pleurotomariæ* which are found on more than one horizon in the British Jurassic rocks. Tawney recognised this species from the Dundry beds ; in Dorset it is only found in the Upper Division of the Inferior Oolite.

A specimen from the Lincolnshire Limestone of Rauceby (fig. 7) is provisionally referred to *Pl. subreticulata*. It differs from the Dorset shells (long type) in its wider spiral angle and less bicarinate whorls. The axial lines or

wrinkles on the posterior areas are, also, strongly developed,—a feature which is emphasised in d'Orbigny's figures, but is probably of no great importance. Morris ('Quart. Journ. Geol. Soc.,' vol. ix, p. 326) quotes *Pl. reticulata*, Desl., with a query, from the Ponton beds.

365. Pleurotomaria textilis, *Deslongchamps*, 1848. Plate XXXVI, fig. 8; including *Pl. scalaris*, Deslongch., fig. 9.

| | | | |
|---|---|---|---|
| 1848. | Pleurotomaria textilis, *Deslongchamps*. | | Vol. cit., p. 63, pl. ix, fig. 2. |
| 1850. | — | — | D'Orbigny, Prod., i, p. 268. |
| 1854. | — | — | D'Orbigny, Terr. Jur., vol. ii, p. 492, pl. cccxci, figs. 6—10. |
| 1873. | — | — | Tawney, Dundry Gasteropoda, p. 53, (45). |
| Syn. or var. | — | scalaris, *Deslongchamps*. | Vol. cit., p. 66, pl. vii, fig. 4; pl. viii, figs. 1, 2, 3; pl. ix, fig. 1. |

*Bibliography, &c.*—Not without hesitation Deslongchamps concluded to separate *Pl. textilis* and *Pl. scalaris*, though doubting the validity of the latter species. Finally he left it an open question. D'Orbigny recognised three species in this group, viz. *Pl. textilis*, Deslongch. ('Terr. Jur.,' vol. ii, p. 492, pl. cccxci); *Pl. strigosa*, d'Orb. (vol. cit., p. 504. pl. cccxcvi); and *Pl. subscalaris*, d'Orb. (vol. cit., p. 505, pl. cccxcvii).

For the present I am content to regard the *scalaris* section of this group as representing megalomorphic forms of *Pl. textilis*, which must be accepted as the specific name.

*Description* (medium size = *Pl. textilis*):

| | |
|---|---|
| Height | 60 mm. |
| Basal diameter | 48 mm. |
| Spiral angle | 56°. |

Shell conical, turrited, not umbilicated. Spire regular. Whorls (about nine) angular and bicarinate or subbicarinate, according to the greater or less prominence of the basal rim. The whorls increase by steps, and in some cases are rather undercut; sutures close. In well-preserved specimens the ornaments of the apical whorls are seen to be reticulate, but in the later whorls spiral ornamentation alone prevails.

The sinus-band is nearly median, large, round, and prominent; and apparently without ornament other than curved growth-lines; it is situate at the angle, and constitutes the greatest salience of each whorl, being more especially conspicuous

where the basal rim is wanting or only slightly developed. The body-whorl is bicarinate, though generally the keel which carries the sinus-band is the more prominent, the intervening space being much excavated. The periphery is more or less angular; base subconvex in the smaller specimens, very tumid in the larger ones, and apparently smooth. Aperture subquadrate, with inner lip but slightly oblique.

*Relations and Distribution.*—This species attains a considerable size, and its megalomorphs (*Pl. scalaris*) present much variety. The smaller forms have some resemblance to *Pl. reticulata*, but may be distinguished by the smooth and rounded sinus-band, and also by the more angular shape of the whorls.

The specimens in my collection are from the *Parkinsoni*-zone of Dorset. Fig. 8 represents a bicarinate specimen of medium size (*Pl. textilis*) from P. 1, Burton Bradstock. From Halfway House are two large specimens, one of which (fig. 9) may be identified as *Pl. scalaris*, var. *stricta*, and another and still larger one (not figured) as *Pl. scalaris*, var. *ambigua*.

Tawney mentions one specimen of *Pl. textilis* from Dundry, but this perhaps is a doubtful identification.

366. Pleurotomaria paucistriata, *d'Orbigny*, 1850. Plate XXXVII, fig. 1.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria paucistriata, *d'Orbigny*. | Prod., i, p. 269. | |
| 1854. | — — — | Terr. Jur., vol. ii, p. 454, pl. cccl xxi. | |
| Syn. | — | proteus, var. paucistriata, *Deslongchamps*. | Vol. cit., p. 48, pl. i, fig. 2. |

*Bibliography, &c.*—This is simply a wide-angled member of the great *Proteus*-group, of which such large specimens are figured in the 'Memoirs of the Linnean Society of Normandy.' The softened outline of the whorls and the paucity of the tuberculations in this "species," together with the general character of the ornamentation, seems to connect the Ornatæ with the Fasciatæ.

*Description:*

| | |
|---|---|
| Height (medium size) . . . . | 55 mm. |
| Basal diameter . . . . | 60 mm. |
| Spiral angle . . . . | 72°. |

Shell conical, turrited, umbilicated. Spire regular. Whorls (eight or nine) angular and increasing by steps, the keel being situated in the posterior third of the whorl. The upper whorls have reticulate ornament, with nodules on the keel; later on the nodules become fainter and gradually disappear, leaving a somewhat naked carina; the spiral ornament is continuous throughout.

The sinus-band is situated a little above the centre of the subcarinal portion of the whorls; it is wide, flat, and non-salient; a strong spiral line in the middle may be noted, but later on this seems to undergo modification. The body-whorl is bicarinate with a sharp angle at the periphery (more like d'Orbigny's figure than his description). Generally, too, the basal angle is subnodular, almost like that in *Pl. subfasciata*. Base flat, with a large umbilical excavation, the spiral striæ being faint and confined to the outer margin. Aperture oval and oblique.

*Relations and Distribution.*—As a member of the *Proteus*-group its relations have already been partially indicated. The figured specimen is from the Iron-shot Oolite of Dundry. I have a large specimen from the *Humphriesianus*-zone of the Sherborne district, and a few smaller ones. It is less abundant than the species next described.

367. Pleurotomaria Proteus, *Deslongchamps*, 1848. Plate XXXVII, fig. 2.

| | | | | |
|---|---|---|---|---|
| 1848. | Pleurotomaria Proteus, var excelsa, | | *Deslongchamps.* | Vol. cit., p. 50, pl. i, fig. 1. |
| 1854. | — | — | *Deslongchamps.* | D'Orbigny, Terr. Jur., vol. ii, p. 453, pl. cccIxx. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 52 (44). |

N.B.—It should be borne in mind that specimens, such as the one figured, are incomplete, and do not attain to the smooth stage, as is the case with the very much larger ones in Normandy.

The height of the largest British specimen known to me is about 50 mm.; whilst the spiral angle is at least 10° narrower than in *Pl. paucistriata;* the whorls are drawn out axially and have a rather different shape, whilst the umbilicus is very narrow. The nodules on the carinæ are bolder and more wide apart in *Pl. Proteus* than in *Pl paucistriata*, but there are intermediate forms. The elongate specimens which I refer to *Pl. Proteus* are most abundant in the *Humphriesianus*-zone of Louse Hill; and, generally speaking, the group is chiefly found in the Sherborne district.

From Louse Hill (upper part of *Humphriesianus*-zone) I have likewise a portion of a large specimen indicative of *Pl. constricta*, Deslongch. This species, as the author remarks (vol. cit., p. 42), links the varieties of *Pl. Proteus* with those of *Pl. armata*.

368. Pleurotomaria armata, *Münster*, 1844. Plate XXXVII, fig. 5.

| | | | | |
|---|---|---|---|---|
| 1844. | Pleurotomaria armata, *Münster*. | | | Goldf., Petref., pl. 186, fig. 7. |
| 1848. | — | — | — | Deslongchamps, vol. cit., p. 39, pl. ii, fig. 2; pl. iii, fig. 2. |
| 1854. | — | — | — | D'Orbigny, Terr. Jur., vol. ii, p. 451, pls. cccIxviii, cccIxix. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 50 (42). |
| Syn. | — | dentata, *Deslongchamps*. | | Vol. cit., p. 37, pl. iv, figs. 1 and 2. |

*Bibliography, &c.*—Münster's species was originally described from the "Upper Oolite" of Streitberg and Vigors; but since it has been identified by Deslongchamps, d'Orbigny, and other palæontologists as a fossil of the French Bajocian, there is no need to step behind their conclusion.

*Description* (especially applicable to the var. *Münsteriana*, Deslongch.):

| | |
|---|---|
| Height | 60 mm. |
| Basal diameter | 75 mm. |
| Spiral angle (approx.) | 100°. |

Shell thick, trochiform, subdepressed, deeply umbilicated. Spire convex. The whorls, six in number, are angular and step-like in their increase, the angle of the whorl being situate about one third the way down, the upper third being nearly flat, and the remaining two thirds nearly vertical. The keels carry thick nodulations at rather wide intervals, and at the base of the lower whorls is a set of tuberous undulations. The sides of the shell are ornamented by richly-cut spirals, which are large and flexuous towards the anterior margin. Sutures rather close and undulating.

The sinus-band is placed about the middle of the height of the whorls; it is wide, flat, and spirally striated, but in the body-whorl smooth and strap-like. The body-whorl is bicarinate, the upper carina being grossly nodular as in the rest of the shell; whilst the lower carina, situate on the basal periphery, is bluntly angular and ornamented with a series of striated undulations rather than nodules, these become fainter anteriorly. Base convex, with marginal striæ and sometimes a marginal furrow; nearly smooth towards the centre, but spirally striated in the cavity. The umbilicus is somewhat funnel-shaped, and very deep. Aperture nearly circular, with some obliqueness of the outer lip.

The var. *precatoria*, Deslongchamps, has a less depressed spire and some slight differences of ornamentation.

*Relations and Distribution.*—This species is one of the most vigorous and charac-

teristic of the Ornatæ, being related on one side to the turrited, and on the other to the depressed forms.

The best specimens are from the *Parkinsoni*-zone of Burton Bradstock, where also the var. *dentata* occurs. From the *Humphriesianus*-zone at Bradford Abbas I have a specimen something between *Pl. armata* var. *precatoria*, and *Pl. Sauzeana*, d'Orb. Smaller and less characteristic specimens of *Pl. armata* are found in the *Sauzei*-bed of the Sherborne district and at Louse Hill, both in the *Humphriesianus*-zone.

369. Pleurotomaria, cf. Sauzeana, *d'Orbigny*, 1850. Not figured.

| | | | | |
|---|---|---|---|---|
| 1850. | Pleurotomaria Sauzeana, *d'Orbigny*. | | | Prod., i, p. 267. |
| 1854. | — | — | — | Terr. Jur., vol. ii, p. 457, pl. cccIxxiii. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 51 (43). |

Specimens referred to this species do not quite fit in with the description and figure in the 'Terrains Jurassiques.' Yet there are specimens from Dundry reaching up to 90 mm. in height, which approach more nearly to *Pl. Sauzeana* than to the most elongate varieties of *Pl. armata*. The fineness of the nodulations in *Pl. Sauzeana* is one characteristic feature. I have already alluded to the specimens from the Irony Bed of Bradford Abbas (*Humphriesianus*-zone). These, together with the Dundry specimens, are distinguished in my Collection as *Pl.* "*sub-Sauzeana*."

370. Pleurotomaria tuberculosa, *Defrance*, 1826. Plate XXXVII, figs. 4 *a*, 4 *b*.

| | | | | |
|---|---|---|---|---|
| 1826. | Pleurotomaria tuberculosa, *Defrance*. | | | Dict. Sci. Nat., vol. xli, p. 382, pl. lxxxvi, fig. 3. |
| 1854. | — | — | — | Morris, Cat., p. 272 (I. O., Bridport). |
| Syn. | — | ornata, *Deslongchamps* (especially var. sulcifera). | | Vol. cit., p. 37, pl. iv, fig. 3. |
| | — | — | — | D'Orbigny, Terr. Jur., vol. ii, p. 449, pls. cccIxvi, cccIxvii. |
| Non. | — | tuberculosa, *Zieten* (1830). | | Verstein. Würt., p. 47, pl. xxxv, fig. 3. |

*Bibliography, &c.*—Deslongchamps, and after him d'Orbigny, regarded this species as identical with *Trochus ornatus*, Sow. Tawney (op. cit., p. 49) did not

accept this view, and I am inclined to agree with him. Certainly one could fill a plate with forms of the Ornatæ which might possibly be regarded as intermediate between *Pl. tuberculosa*, Defrance, and *Pl. ornata*, Sow. But under any circumstances the fossils we are now considering differ so widely from the average form of Sowerby's species as to merit distinction. Since a name is required, that of "*tuberculosa*" is certainly appropriate. The type was obtained from "near Caen in the Oolite bed."

*Description :*

| | |
|---|---|
| Height . . . . . | 25 mm. |
| Basal diameter . . . . | 55 mm. |
| Spiral angle . . . . | 128°. |

Shell turbinate, much depressed, widely umbilicate. The spire, though low, is regular. Whorls (six) angular, and increasing by wide steps with a canaliculate suture. The angle of each whorl is ornamented with very thick tubercles, and the entire shell is pervaded by fine spiral lines, radially decussated in the earlier whorls, and undulating towards the anterior margin of the later ones.

The sinus-band is rather wide, flat and submedian; its ornaments vary with the ornaments of the whorls, but anteriorly have a tendency to disappear, showing only sinuous growth-lines. The body-whorl is relatively very large, euomphaloid, and bicarinate; the upper keel is grossly nodular; in the lower keel the nodules are drawn out spirally, exhibiting a dentate periphery. Base round, with a large infundibuliform umbilicus. Aperture oval, depressed.

*Relations and Distribution.*—This is pretty near to *Pl. ornata*, var. *sulcifera*, Deslongch. The form is rare in England. The best specimens come from Louse Hill (*Humphriesianus*-zone). The fossil quoted by Morris as from the "I. O. Bridport" came most probably from Burton Bradstock, whence also I have seen specimens of *Pl. tuberculosa*.

371. Pleurotomaria ornata, *Sowerby*, 1818. Plate XXXVII, figs. 3 *a*, 3 *b*, 3 *c*.

1818. Trochus ornatus, *Sowerby*. Min. Conch., pl. ccxxi, fig. 1.
Syn. 1823. — Pallium, *Farey*. Sowerby, Min. Conch., vol. iv, Index (Corrigenda).
1843. Pleurotomaria Pallium, *Sowerby*. Morris, Cat., p. 158 (edition of 1854, p. 271).
1873. — — *Morris*. Tawney, Dundry Gasteropoda, p. 49 (41).

*Bibliography, &c.*—So long as this species was referred to the genus *Trochus*, the name selected by Sowerby was open to Farey's correction. Subsequently

Defrance, in constituting the genus *Pleurotomaria*, applied the name "*ornata*" to quite a different species (*vide infra*). This was accepted by Morris, who accordingly retained the name "*Pallium*" for Sowerby's species, and Tawney followed suit. It is now proposed to restore Sowerby's specific name.

*Description* (Sherborne variety) :

| | |
|---|---|
| Height . . . . . | 30 mm. |
| Basal diameter . . . . | 42 mm. |
| Spiral angle . . . . . | 90°. |

Shell turbinate, subdepressed, umbilicate. Spire regular, apex pointed. Whorls (six to seven) angular to subconvex and increasing by steps; sutures canaliculate. On the flattened posterior area of all the whorls is a system of close tubercular undulations drawn out radially, whilst the spiral ornamentation is rather faint; in some specimens an anterior crenulated belt is developed.

The sinus-band is median, flat and retreating in the upper whorls, rounder and more prominent in the lower ones; it is mostly without markings other than the usual sinuous growth-lines. The body-whorl is large and subconvex, with the undulating radial costæ on the posterior area well developed, and sometimes the prominence of the sinus-band almost constitutes a keel; it is bluntly angular at the periphery, which is subcrenulate to smooth in many of the Sherborne specimens. Base convex, with radial ornamentation preponderating over the spiral; umbilicus rather small. Aperture oval-depressed.

*Varieties.*—The Sherborne specimens present many varieties amongst themselves, some being less glabrous and with more marginal crenulation than the one figured. From other districts are specimens in which the whorls are more angular, the tuberculations wider apart, and the base rather flatter with well-marked spiral ornament. On the other hand, the Sherborne variety develops glabrous forms where the whorls are smooth-convex, the base tumid, and the umbilicus almost *nil*.

*Relations and Distribution.*—*Pl. ornata*, Sow., is essentially a small form, rarely exceeding 30 mm. in height. It can hardly be regarded as the young of *Pl. tuberculosa*, though without doubt the species recognised in the *Ornata*-group have a tendency to inosculate. On the other hand, the narrow and prominent character of the sinus-band in the body-whorl, and the rounding off of the whorls, so different from that of the Ornatæ generally, seem to connect *Pl. ornata*, Sow., with some of the Granulatæ, more especially with *Pl. granulata*, Sow.

The type was from Dundry. The variety above described is abundant in the *Sauzei*-bed at Oborne. Very characteristic specimens, obtained from Dundry, are to be seen in the Bristol Museum. These have somewhat bolder ornaments than the figured specimen, but in other respects agree.

372. Pleurotomaria ornata-depressa, sp. nov. Plate XXXIX, figs. 3 *a*—*c*.

Cf. Cirrus carinatus, *Sowerby*. Min. Conch., pl. ccccxxix, figs. 3, 4.

*Description :*

| | |
|---|---|
| Height . . . . . | 14 mm. |
| Basal diameter . . . . | 40 mm. |
| Spiral angle . . . . . | 135°. |

Shell turbinate, subdiscoidal, umbilicate. Spire regular. Whorls (about five) angular and discoidal; sutures strongly canaliculate. The spiral ornamentation is well developed, and, in addition, the crown of each whorl carries a zone of undulating radial tubercles regularly disposed.

The sinus-band is wide, median and flat, with traces of spiral lines, which, however, are not seen anteriorly. The body-whorl is relatively large and similar in character to the whorls of the spire, with an angular periphery and flattish base richly decussated; umbilicus deep rather than wide. Aperture oval-depressed.

*Relations and Distribution.*—The figured specimen is from Bradford Abbas most probably from the *Concavus*-bed. Small depressed forms, with somewhat similar ornamentation, occur in the *Murchisonæ*-zone of the Cotteswolds; I also possess a cast from Leckhampton which corresponds well with this figure. *Pl. ornata-depressa* may be regarded as the most depressed variety of the *Ornata*-group. A large specimen showing similar ornamentation, but with a rounder body-whorl and rather higher spire, presents us with another variety of the *Ornata*-group. This is from Dundry.

*Note* respecting *Cirrus carinatus*.—It will be remembered that this very discoidal cast came from Leckhampton. Presuming that it is the cast of a *Pleurotomaria*, this makes one of the three Jurassic species of which the actual figured specimen is preserved in the Sowerby type collection at the British Museum.

Unfortunately, the name "*carinata*" as applied to *Pleurotomaria* is bespoken for a Palæozoic fossil, viz. *Pleurotomaria* (*Helix*) *carinata*, Sowerby ('Min. Conch.,' pl. x, upper and lower figures).

373. Pleurotomaria Actæa, *d'Orbigny*, 1850. Plate XXXVII, fig. 8.

| | | | | |
|---|---|---|---|---|
| 1850. | Pleurotomaria Actæa, *d'Orbigny*. | | | Prod., i, p. 267. |
| 1854. | — | — | — | Terr. Jur., vol. ii, p. 459, pl. ccclxxv. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 50 (42). |

*Description:*

| | |
|---|---|
| Height . . . . . | 45 mm. |
| Basal diameter . . . . | 75 mm. |
| Spiral angle . . . . . | 120°.[1] |

Shell turbinate, depressed, umbilicate. Spire convex. Whorls (six to seven) subangular, and increasing by steps with a canaliculate suture. The crest of each whorl is surmounted by a diadem of tubercles, rather small and oblique but somewhat closely set, whilst flexuous spiral lines ornament the sides of all the whorls; moreover in some cases the posterior margin of each whorl shows a ridge lying between two furrows, in the upper of which is the suture, whilst the lower furrow constitutes a sort of trough immediately behind the diadem of tubercles. In other cases there is a slight anterior keel at the base of each whorl.

The sinus-band is broad and median, and shows three spirals in the earlier whorls; but there is great variety in this respect, and also in the degree of its prominence; in the body-whorl of very large specimens it is flat and scaly. The body-whorl is relatively very large and biangular, the upper carina being surmounted with tubercles, whilst the lower one, forming the angle or basal periphery, is little more than crenulated in some specimens. The base is subconvex and without any special ornament, but the flexuous growth-lines are very conspicuous, and may be traced into the deep and funnel-shaped umbilicus. Aperture subovate-depressed.

The younger forms have a strongly dentate periphery and actinomphaloid base, but the umbilicus is not so wide as in *Pl. actinomphala*.

*Relations and Distribution.*—This is one of the representatives, on a higher horizon, of *Pl. actinomphala;* but the spire is more convex, the ornaments are different, the body-whorl is more angular, and the rugose character of the base appears to be modified. There is, however, much variety.

It was quoted by d'Orbigny from Dundry, from which locality I have one specimen. By far the best specimens come from the *Sauzei*-bed at Oborne. I have one in a good state of preservation which has a basal diameter of 100 mm.; in this one the basal periphery has become quite smooth. No other horizon in Dorset has, to my knowledge, yielded *Pl. Actæa*.

[1] D'Orbigny gives the spiral angle as 102°, but his figured specimen shows an angle of 110°. It seems probable that the Dorset specimens are wider on the whole.

374. Pleurotomaria oxytera, sp. nov. Plate XXXVII, fig. 6.

*Description:*

| | |
|---|---|
| Height . . . . . | 35 mm. |
| Basal diameter . . . . | 55 mm. |
| Spiral angle . . . . . | 92°. |

Shell conical, trochiform, moderately umbilicated. Spire regular or very slightly concave; apex sharp. Number of whorls about eight; those at the apex slope regularly, but presently become subgradate, sutures close and not canaliculate. The spiral system of ornament is strong, undulating, and rather wide apart; there is a diadem of regular and rather fine tubercles at the angle and another at the base of each whorl, which is subbicarinate.

The sinus-band is median, prominent, and pretty wide, but varies in the different whorls; showing from one to three spirals, though this feature is effaced in the body-whorl, where it is somewhat flattened. The posterior area of the body-whorl is mostly without tuberculation, but the lower keel is very prominent and nodular, showing a strongly dentate periphery. Base convex, without marked spiral ornament, deeply but not widely umbilicate, and very actinomphaloid, the larger specimens being smoother. Aperture subrhomboidal and oblique.

*Relations and Distribution.*—Distinguished both from *Pl. Actæa* and *Pl. actinomphala* by its conical habit and sharp spire, it approaches the latter in the character of its ornamentation, whilst the actinomphaloid base is a feature shared by all three species. It is very directly connected with the acute variety of *Pl. actinomphala*, but the umbilicus is always smaller, and there are other differences.

I have three specimens from the *Sauzei*-bed, Oborne.

375. Pleurotomaria actinomphala, *Deslongchamps*, 1848. Acute variety, Plate XXXVII, figs. 7 *a*, 7 *b*, and Plate XXXVIII, fig. 5. Obtuse variety, Plate XXXVIII, figs. 1—4.

| | | | | |
|---|---|---|---|---|
| 1848. | Pleurotomaria actinomphala, *Deslongchamps*. | | | Vol. cit., p. 32, pl. xviii, fig. 1. |
| 1854. | — | — | — | D'Orbigny, Terr. Jur., vol. ii, p. 458, pl. cccl xxiv. |
| 1873. | — | — | — | Tawney, Dundry Gasteropoda, p. 49 (41). |

*Bibliography, &c.*—It should not be forgotten that the types of *Pl. actinomphala* occur in the "Mâlière" of Normandy, a bed underlying the "Oolithe ferrugineuse." Deslongchamps speaks of it as being common in the condition of casts. It so happens that in the *Concavus*-bed at Bradford Abbas, which should be somewhat about the horizon of the "Mâlière," *i. e.* in the Lower Division of the Inferior Oolite, a group of *Pleurotomaria* occurs, exhibiting great variety both as to size and form, but which, without using varietal names, it may be convenient to focus under *Pl. actinomphala*.

Similarly, it seems probable that considerable variety exists in the specimens from France, if we are to regard the figures of Deslongchamps and d'Orbigny as representing the same species.

*Description.*—Amidst a multiplicity of fossils of all ages and sizes, and with much variety of character, there are two groups of varieties which attract our attention.

*Acute Variety* (Pl. XXXVII, fig. 7, and Pl. XXXVIII, fig. 5).—The form is conical, and the shell may have a smooth periphery as in the first figure, or a rugose periphery as in the second. Generally speaking, this form is rugose in ornament, and it seems, on the whole, more nearly to represent the *Pl. actinomphala* of the French authors. It is also intimately related to *Pl. oxytera*, described above, though the whorls are always more tabulate.

I have specimens of this variety, chiefly from the *Concavus*-bed at Bradford Abbas and Halfway House, also from Dundry, and even from the neighbourhood of Sherborne.

*Obtuse Variety* (*actinomphala-abbas*) :

| | |
|---|---|
| Height (moderate size) . . . | 42 mm. |
| Basal diameter . . . . | 65 mm. |
| Spiral angle . . . . . | 110°—115°. |

Shell turbinate, depressed, largely umbilicate. Spire regular; apex subacute. Whorls (seven) subangular and inclined to be tabulate, increasing by steps; in the spire-whorls the suture is canaliculate. On the crest of each whorl is a corona of tubercles, which are regular, and there is a certain amount of spiral ornamentation, which is rather worn off in the older specimens; there is no trace of a second carina or belt at the base of the whorls.

The sinus-band is median, wide, and flat, showing some spiral lines in the younger and better preserved specimens, but usually smooth and strap-like in the later ones. The body-whorl is relatively very large, convex, and biangular, the anterior angle being nodular to smooth according to age and condition. The base is convex and without much trace of spiral ornament, except in very young shells; umbilicus wide, steep, and like a "staircase" in the earlier stage, with large ribs radiating therefrom, though scarcely reaching the margin. In the old shells these

flexuous radii in the base, so characteristic of the species, are lost, and only growth-lines remain. Aperture subcircular.

[*Note* as to the figures on Plate XXXVIII.—*Figs.* 1 *a*, 1 *b*, represent two aspects of the early adult stage, where strong traces of the actinomphaloid character still remain. *Fig.* 2 represents three aspects of the early stage of one of the more rugose forms. Specimens of this size and character are very common in the *Concavus*-bed at Bradford Abbas, though showing much variety amongst themselves. *Fig.* 3 represents two aspects of the early stage of a smooth variety, where the staircase-like character of the umbilicus is preserved, but the umbilical rays are almost wanting. *Figs.* 4 *a*, 4 *b*, represent the last stage of *Pl. actinomphala-abbas*, where the actinomphaloid character is entirely lost, and the shell is smooth alike from age and wear. Of these forms, too, there is a very great variety. Most of them exhibit a tendency to gibbosity in the penultimate whorl; there is also considerable variety in the degree of depression, and in some instances the whorls of these old shells are so much undercut as to produce quite a different figure.]

All the above are from the *Concavus*-bed, Bradford Abbas. In the *Murchisonæ*-zone of that locality are specimens which one hardly knows whether to refer to *Pl. actinomphala*, *Pl. Aglaia*, or *Pl. Baugieri*.

376. Pleurotomaria Baugieri, *d'Orbigny*, 1850. Plate XXXIX, figs. 4 *a*, 4 *b*, 4 *c*; and var., figs. 5 *a*, 5 *b*, 5 *c*.

1850. Pleurotomaria Baugieri, *d'Orbigny*. Prod., i, p. 267.
1854. — — — Terr. Jur., vol. ii, p. 463, pl. cccIxxviii, figs. 2—4.

*Description.*—Though not attaining to so large a size, the English specimens correspond satisfactorily with those described by d'Orbigny.

| | |
|---|---|
| Height (average) . . . . | 10 mm. |
| Basal diameter . . . . | 28 mm. |

Shell subdiscoidal, largely umbilicate. The spire is coiled almost in the same plane, and is composed of whorls which are subangular and in shallow gradations. The whorls are spirally striated, and provided near the upper margin with a furrow, the remainder of the space being radially ornamented with about twenty costæ having tubercular terminations.

The sinus-band is placed near the outer margin in the furrow, wide, slightly sunken, and flanked by raised lines. The body-whorl is subdiscoidal and bluntly biangular; the upper carina is formed by the nodular terminations of the radial ornaments; the lower, or peripheral carina, is also strongly nodular and

salient, and between these lies the sinus-band. Base subconvex, with a marginal furrow, and spiral lines decussated by strong radii. Umbilicus wide and deep, exhibiting the inner coil of the whorls.

*Varieties.*—Specimens, such as fig. 5, present some modifications of ornament with a higher spire. These seem to connect with *Pl. Aglaia*, d'Orb. (vol. cit., p. 469, pl. cccIxxxi, figs. 1—5). There is also another form (not figured) from the *Murchisonæ*-zone of Bradford Abbas, which may possibly represent a variety of this species. This latter I have hitherto considered to represent an early stage of *Pl. actinomphala* on a lower horizon.

*Relations and Distribution.*—Closely related to *Pl. actinomphala*, the position of *Pl. Baugieri* both in France and in England lies in the Lower Division of the Inferior Oolite. Nearly all my specimens are from the *Murchisonæ*-zone of Bradford Abbas.

377. Pleurotomaria mopsa, *d'Orbigny*, 1850. Plate XXXIX, figs. 6 *a*, 6 *b*, 6 *c*.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria mopsa, *d'Orbigny*. | | Prod., i, p. 230. |
| 1854. | — | — — | Terr. Jur., vol. ii, p. 421, pl. ccclv, figs. 6—10. |
| Syn. | — | Debuchii, var. exsertiuscula, *Deslongchamps*. | Vol. cit., p. 93, pl. xv, fig. 10. |

*Bibliography, &c.*—So many forms were grouped by Deslongchamps under the "species" named *Debuchii* that d'Orbigny concluded to break it up. *Pl. Debuchii* and all its varieties are mainly Liassic, but traces of some of them certainly occur in the Lower Division of the Inferior Oolite.

*Description:*

| | |
|---|---|
| Height . . . . . | 13 mm. |
| Basal diameter . . . . | 27 mm. |
| Spiral angle . . . . . | 140°. |

Shell subdiscoidal, largely umbilicate. Spire low but regular. Whorls (six) increasing by steps, angular and carinate, posterior areas tabulate and wide, anterior areas sloping at an angle of 60°; suture canaliculate. The flat part of the whorls is ornamented by three (in the body-whorl sometimes four) raised tuberculated spirals, the outermost occupying the keel (in the body-whorl the nodules are fused into an appearance of radial costæ); the anterior sloping area is decussated, but more than half its total width is occupied by the sinus-band.

The sinus-band is wide, flat, and rather receding; it is margined above and below by a spiral line, with a single central line decussated; in the last whorl it occupies a position between the nodulated keel and the more prominent basal

angle. The body-whorl is relatively very large, subdiscoidal, and convex, forming a blunt angle at the periphery; this angle carries about three decussated spirals, nodose at the points of intersection. The base is tumid, and largely excavated by the funnel-shaped umbilicus; strong spirals are decussated by sinuous radii not extending quite to the margin. Aperture ovate-depressed.

*Relations and Distribution.*—One of the most prominent features in this species is presented by the radial costæ of the flat part of the whorls, and this likewise is characteristic of the other varieties of *Pl. Debuchii*.

My specimens are from the *Murchisonæ*-zone of Chideock and Bradford Abbas, and there are smaller ones, with a rounder basal periphery, from the *Concavus*-bed. Rare.

A micromorph closely resembling *Pl. platyspira*, d'Orb. ( = *Pl. Debuchii*, var. *platyspira*, Deslongch.), occurs in the *Murchisonæ*-zone at Crickley.

378. Pleurotomaria mirabilis, *Deslongchamps*, 1848. Micromorph. Plate XXXIX, figs. 7 *a*, 7 *b*, 7 *c*.

1848. Pleurotomaria mirabilis, *Deslongchamps*. Vol. cit., p. 31, pl. xvi, fig. 2.
1854. — — — D'Orbigny, Terr. Jur., vol. ii, p. 433, pl. cccIvii.

There are two specimens in my collection (one figured), which possess the characteristic euomphaloid shape, sunken spire, wide umbilicus, and general ornamentation of this remarkable Middle Lias species. The ornaments on the upper side present some difference, being finer and less nodose. The specimens are small, the breadth averaging about 20 mm. Provisionally labelled *Pl.* "*submirabilis*"; there is scarcely sufficient material for constituting a new species. Believed to come from the *Murchisonæ*-zone of Bradford Abbas.

From the above it may be gathered that we have three Middle Lias species reappearing in the *Murchisonæ*-zone, viz. *Pl. Mopsa*, *Pl. platyspira*, and *Pl. mirabilis*; the two latter as micromorphs.

379. Pleurotomaria subaraneosa, sp. nov. Plate XXXIX, figs. 1 *a*, 1 *b*.

*Description:*

| | |
|---|---|
| Height (medium size) . . . . | 38 mm. |
| Basal diameter . . . . | 45 mm. |
| Spiral angle . . . . | 85°. |

Shell conical, turrited, only slightly umbilicate. Spire regular and sharp, except just at the apex, where it is rather flattened. Whorls in a medium-sized specimen seven, angular, the posterior third having a moderate slope, and the anterior two-thirds being nearly vertical; sutures close and not canaliculate. The keel of each whorl carries a coronet of undulating tubercles, and the whole shell is pervaded by fine and close undulating spiral ornament, which is decussated by extremely fine radial lines.

The sinus-band is wide, flat, and submedian, with spiral striæ decussated by growth-lines, and this kind of ornamentation is continued throughout, except in the body-whorl of very large specimens. The body-whorl is large and biangular; the lower keel, or basal periphery, is scarcely tuberculate, and in very large specimens almost smooth. The base is flat-convex with extremely fine reticulate ornament; the umbilicus is small and inconspicuous, but rather deep in some of the younger forms. Aperture square to subcircular.

*Relations and Distribution.*—In *Pl. intermedia*, Münster (Goldfuss, pl. clxxxi, 5), which is said to occur in the Lias, we have in many respects a very similar shell; but in that species the sinus-band is represented as occurring on the keel. *Pl. subaraneosa* is little more than a modified form of *Pl. araneosa*, var. *reticulata*, Deslongch. (vol. cit., p. 89, pl. xiv, fig. 5), thus affording another instance of a Liassic survival. Our shell, however, is rather more subdued in ornaments and presents some minor points of difference; which facts, coupled with its comparative abundance in the *Concavus*-bed at Bradford Abbas, seem to entitle it, provisionally at least, to be regarded as a distinct species.

At Bradford Abbas the majority of the specimens are immature, consisting of about five or six whorls. The fine and close reticulate ornamentation is well exhibited in some of these, and there is a specimen from the same horizon at Beaminster where the close and delicate spiral system in the base is well brought out. On the other hand, the base of the larger specimens appears smooth (? from wear). Individuals with eight whorls attain to a large size (basal diam. 80 mm.). In these the umbilicus is almost closed, and the shells present the appearance of having been worn. There is a specimen from Dundry, in Mr. Wilson's Collection, where the ornamentation in the spire is bolder (or better preserved), and this still more nearly resembles *Pl. araneosa*.

In this connection, also, I would draw attention to a specimen (Pl. XXXIX, figs. 2 *a*, *b*) from the Liassic Sands of Gloucestershire, where the ornamentation is bolder than in *Pl. subaraneosa*, and altogether more like that of Deslongchamps' species. N.B.—The actual specimen does not warrant the amount of umbilicus shown in the figure.

Secondly, there remains for consideration the large species of *Pleurotomaria* occasionally found in the lower part of the Yorkshire Dogger, and identified by me

in a general sort of way with *Pl. Anglica*, Sow. I quote the following:—"Owing to the imperfect condition of the shell, an absolutely correct identification of the Dogger fossil with this or that member of the *Anglica*-group is almost impossible. It comes very near to *Pl. araneosa*, Desl." ('Geol. Mag.,' dec. 3, vol. ii, p. 154, pl. iv, fig. 5). This is about as near as we can get pending the discovery of better specimens.

N.B.—Whatever may have been the original or originals of *Pl. Anglica*, Sowerby, that species seems now to be restricted to certain wide-angled tabulate forms which occur in the Lower Lias.

380. Pleurotomaria Yeovilensis, *Tawney*, 1873. Plate XXXIX, figs. 8 *a*, *b*, *c*; and var. rugosior, figs. 9 *a*, *b*.

1873. Pleurotomaria Yeovilensis, *Tawney*. Dundry Gasteropoda, p. 52 (44), pl. iii, fig. 4.

*Bibliography, &c.—Pl. Yeovilensis* was described by Tawney at a time when good specimens were rare. The locality "Yeovil" was given because so many of the Bradford Abbas fossils in those days were supplied to collections and museums by "fossil-men" who resided at Yeovil, the nearest town to Bradford Abbas.

The species is one of remarkable beauty, and interesting as the representative of the Granulatæ in the Lower Division of the Inferior Oolite. *Pl. Alcibiades* is possibly a more depressed and less ornamented form; this, too, in France most likely occurs on a low horizon, not being noted from the "Oolithe ferrugineuse."

*Description:*

| | |
|---|---|
| Height | 17 mm. |
| Basal diameter | 30 mm. |
| Spiral angle | 105°. |

Shell conical-depressed, deeply umbilicate. Spire regular and sharp, with a slightly flattened apex. Whorls (seven) subangular and sloping; suture subcanaliculate. The whorls exhibit fine reticulate ornaments, having the tendency to become granulate; whilst in the two last whorls an elegant tuberculate corona is developed on the posterior ridge, the tubercles radiating away from the centre.

The sinus-band is very salient, being situated at the anterior angle in the whorls of the spire; it has granulated spiral lines to the number of three. The body-whorl is relatively very large, and, in addition to the posterior corona and the prominence of the sinus-band, exhibits a thick tuberculated belt at the periphery; these tuberculations are drawn out radially, and correspond to the tuberculations of the corona. The base is subconvex, being excavated by a deep

marginal furrow, from which it rises towards the edge of the umbilicus: throughout the base spiral lines are decussated by bold sinuous radii, which die out before reaching the marginal furrow. The umbilicus is steep and smooth, and so deep as to expose the internal coils. Aperture oval, depressed.

Var. *rugosior*.—Of somewhat larger habit than the preceding. The spiral angle is scarcely 90°; consequently the sides of the shell are steeper, whilst the ornaments are coarser, especially throughout the base; the umbilicus, too, is narrower, but equally steep and penetrating.

*Relations and Distribution*.—Although *Pl. Yeovilensis* possesses considerable general resemblance to *Pl. Baugieri*, especially in its basal aspect, the very different character of the sinus-band forbids them being placed even in the same section. It is not impossible, however, that the Ornatæ and the Granulatæ may, to a certain extent, approach each other in these two species.

Practically, then, as a member of the Granulatæ, *Pl. Yeovilensis* stands alone in the *Concavus*-bed of Bradford Abbas, where excellent specimens are by no means rare. If we desire to see the change wrought through lapse of time we have a remarkable instance in the var. *rugosior*, which represents this species on the next horizon, viz. the *Sauzei*-bed of Oborne. Specimens from Beaminster and Dundry are rare, and not very satisfactory. There is one specimen in my Collection from Bradford Abbas, which in its depressed spire and soft ornamentation might almost pass for *Pl. Alcibiades*.

381. Pleurotomaria granulata, *Sowerby*, 1818. Plate XXXIX, figs. 10 *a*, 10 *b*, 10 *c*; and Plate XL, figs. 1, 1 *a*.

1818. Trochus granulatus, *Sowerby*. Min. Conch., pl. ccxx, fig. 2.
1873. Pleurotomaria granulata, *Sowerby*. Tawney, Dundry Gasteropoda, p. 47 (39).
Syn. — — vars. reticulata and cœlata, *Deslongchamps*. Vol. cit., p. 101, pl. xvi, figs. 6 and 8.

*Bibliography, &c.*—Morris ('Cat.,' p. 271) quotes *Pl. granulata*, Sowerby, from the Corallian of Malton and Scarborough; and also from the Inferior Oolite of Blue Wick (Dogger). There is no justification for this. He also quotes the species from Dundry, which is correct.

The forms described below, which I regard as being nearly if not absolutely identical with *Trochus granulatus*, Sow., may be accepted as the central figures of the *Granulata*-group, the others being regarded as species or varieties according to individual opinion.

*Description :*

| | |
|---|---|
| Height (elevated variety) | 28 mm. |
| Basal diameter | 40 mm. |
| Spiral angle | 95°. |

Shell conical-depressed, slightly umbilicated. Spire regular and sharp, the angle ranging from 95° to about 110°. Whorls (seven) flat and sloping, with a close suture which is scarcely canaliculate. The ornamentation is granulated throughout, a feature arising from an elevated decussation of the spiral and radial lines. A belt which is studded with a kind of triple tuberculation forms the base of each whorl, but the ornaments of this belt are subject to modification, and its character is sometimes changed owing to the undercutting of the whorls.

The sinus-band is anterior, round, and prominent, but not wide. In the earlier stages are spiral lines decussated, but in the later stages the growth-lines alone are seen, very closely packed (Pl. XL, fig. 1). The body-whorl is relatively large with granulate ornament and a blunt belt, or basal carina, richly granulated or tuberculated, these tuberculations losing their sharpness towards the anterior extremity. Base convex, with spiral ornamentation rather faint, generally wanting in the middle portion of the base, though the radial lines are pretty strong. Umbilicus rather small, and inclined to be funnel-shaped. Aperture subrhomboidal.

*Relations and Distribution.*—Originally described from Dundry, *Pl. granulata* swarms in the *Sauzei*-bed at Oborne and other localities in the Sherborne district. There is a wide-angled variety from Milborne Wick (XXXIX, 10) which, to a certain extent, prefigures forms that are characteristic of the *Parkinsoni*-zone, *e. g. Pl. Palæmon.*

382. Pleurotomaria phylax, sp. nov. Plate XL, figs. 4 *a*, 4 *b*, 4 *c*.

This rather curious shell is found rarely in the *Sauzei*-bed at Oborne, and may be a sport or megalomorph of the more depressed variety of *Pl. granulata*. The sinus-band, however, presents considerable differences.

*Description :*

| | |
|---|---|
| Height | 25 mm. |
| Basal diameter | 44 mm. |
| Spiral angle | 115°. |

Shell conical-depressed, thick, slightly umbilicate. Spire rather convex with a very obtuse apex. Whorls (six) sloping regularly to the basal carina, which in some cases is rather undercut. The spiral ornamentation is delicate and regular

throughout, but the radial decussation is so slight that the shell is merely subgranulate.

The sinus-band is below the middle and not conspicuous, owing to the resemblance of its spiral lines to the general spiral system; there is a strong central line and a fine one on each side. The body-whorl is bluntly angulated at the periphery and carries an obtuse carina with about three subgranulate spirals, corresponding to the basal keels in the spire whorls. Base extremely convex, with well-marked spirals only faintly decussated by radii; umbilicus small. Aperture ovate to subrhomboidal.

N.B.—The three following "species" represent the *Granulata*-group in the *Parkinsoni*-zone, and exhibit a sequence of forms from the flat and delicately-sculptured *Pl. Palæmon* to the turrited and rugose *Pl. trapeza*, the species next described occupying the middle position.

383. Pleurotomaria plicopunctata, *Deslongchamps*, 1848. Pl. XL, figs. 2 *a*, 2 *b*, 2 *c*.

1848. Pleurotomaria granulata, var. plicopunctata, *Deslongchamps*. Vol. cit., p. 102, pl. xvi, figs. 7 *a*, *b*.

Syns. — ornata, *Defrance*. Dict. Sci. Nat., vol. xli, p. 382, pl. lxxxvi, fig. 2.

— — — Deshayes, Coq. caract., p. 179, pl. iv, fig. 3.

— granulata, *Deslongchamps*. D'Orbigny, Terr. Jur., vol. ii, p. 466, pl. cccl xxx, figs. 1—6.

— ornata, *Defrance*. Morris, Cat., p. 271.

— Defrancii, *Hudleston and Wilson*. Cat. Brit. Jur. Gast., p. 102.

*Bibliography, &c.*—Owing to the original misapprehension of Defrance in identifying this member of the *Granulata*-group with Sowerby's *Trochus ornatus*, there has been a considerable amount of confusion in the nomenclature. Endeavouring to escape from the labyrinth of "granulatas" and "ornatas" which invested it, Messrs. Hudleston and Wilson proposed the specific name "*Defrancii*." This had, however, been already applied by d'Archiac and de Verneuil ('Trans. Geol. Soc.,' 2nd series, vol. vi, p. 360) to a palæozoic *Pleurotomaria*. In order to distinguish this species it seems best to fall back on Deslongchamps' varietal name.

*Description:*

| | |
|---|---|
| Height . . . . . | 16 mm. |
| Basal diameter . . . . | 35 mm. |
| Spiral angle . . . . . | 125°—130°. |

Shell depressed, umbilicus deep and narrow. The spire is convex-depressed with a flattened apex. Whorls (seven) flat and sloping, and ornamented with oblique radial costæ which are granulate at the points of intersection with the spiral system.

The sinus-band forms a narrow, prominent ridge rather more than halfway down; owing to its prominence the spiral lines have not been well preserved, the general appearance being that of a narrow, winding cord. The body-whorl is relatively large, angular-compressed, and provided with a narrow, tuberculated carina at the periphery; base very convex and ornamented with a system of flexuous radial costæ, which spring from the margin of the small but deep umbilicus. Aperture oval-depressed and oblique.

*Relations and Distribution.—Pl. plicopunctata* differs from *Pl. granulata* in being more depressed, in its narrow but deep umbilicus, and especially in the conspicuous radial ornamentation of the base. In both there is a tendency to develop a tuberculated basal carina in the lower whorls of the spire, which adds materially to the beauty of the shell.

It is mainly a fossil of the *Parkinsoni*-zone, being especially abundant at Burton Bradstock, Vitney Cross, &c., also in the *Parkinsoni*-zone of Bradford Abbas, Stoford, &c. There is considerable variety, with a tendency on the one hand to pass into *Pl. Palæmon*, and on the other into *Pl. trapeza*.

384. Pleurotomaria Palæmon, *d'Orbigny*, 1850. Plate XL, figs. 3 *a*, 3 *b*, 3 *c*.

| | | | |
|---|---|---|---|
| 1850. | Pleurotomaria Palemon, *d'Orbigny*. | | Prod., i, p. 267. |
| 1854. | — | — | — Terr. Jur., vol. ii, p. 468, pl. ccclxxx, figs. 7—11. |
| 1873. | — | Palæmon, *d'Orbigny*. | Tawney, Dundry Gasteropoda, p. 48 (40). |
| Syn. | — | granulata, vars. lentiformis and lævigata, *Deslongchamps*. | Vol. cit., p. 101, pl. xvi, figs. 4 and 5. |

*Bibliography, &c.*—It is pretty clear that Tawney, in quoting this species, was disposed to include both *Pl. plicopunctata* and *Pl. Palæmon* under the latter designation. Undoubtedly they are near relatives.

*Description:*

| | |
|---|---|
| Height | 13 mm. |
| Basal diameter | 35 mm. |
| Spiral angle | 142°. |

The sunken spire, fineness of the lines, and the absence of coarse radial ornamentation in the base, are the principal features which separate *Pl. Palemon* from the preceding species. It is essentially a fossil of the *Parkinsoni*-zone, and

possibly also of the higher parts of that zone. I have one specimen from Shotwell, which in all respects corresponds with d'Orbigny's figure. The specimen figured in the accompanying plate (Pl. XL, fig. 3) is between this extremely smooth form and the ordinary *Pl. plicopunctata*.

385. Pleurotomaria trapeza, sp. nov. Plate XL, figs. 5 *a*, 5 *b*.

*Description:*

| | |
|---|---|
| Height . . . . . | 35 mm. |
| Basal diameter . . . . | 44 mm. |
| Spiral angle . . . . . | 95°. |

Shell trochiform, subtabulate, slightly umbilicated. Spire regular, with sharp apex. Whorls (seven) angular, and increasing by steps; the posterior area has a moderate slope, whilst the anterior area (below the sinus-band) is almost perpendicular, and constitutes a broad costated girdle round each whorl; sutures close. The spiral system is overpowered by strong radial costæ, which are oblique above the sinus-band and axial below.

The sinus-band is narrow and prominent, being situated mesially at the angle of the whorl; owing to its prominence the ornaments seem worn. The body-whorl is large and bluntly angular at the periphery, so as to be slightly biangular Base very convex, with spiral ornamentation stronger than the radial; umbilicus small. Aperture subquadrate

*Relations and Distribution.*—Intermediate forms between this and the larger varieties of *Pl. plicopunctata* may be noted, and yet there is a tolerably sudden jump at last; whilst in the narrowing of the spiral angle there is a sort of return to *Pl. granulata* of the lower horizon. Still I do not doubt that this is a kind of offshoot from the common "granulate" *Pleurotomaria* of the *Parkinsoni*-zone (*i. e. Pl. plicopunctata*). Moreover it is of importance with reference to the occurrence of a tabulate form connected with the Granulatæ on higher horizons, such as *Pl. granulata*, Lycett, of the Scarborough Cornbrash, and even *Pl. Münsteri*, Röm. (*Pl. filigrana*, Deslongch.), of the Lower Corallian. See page 440 with reference to Morris' identification of *Pl. granulata* on different horizons.

*Pl. trapeza* is found at Burton Bradstock, and may be expected to occur at Broadwinsor, and other localities of the *Parkinsoni*-zone.

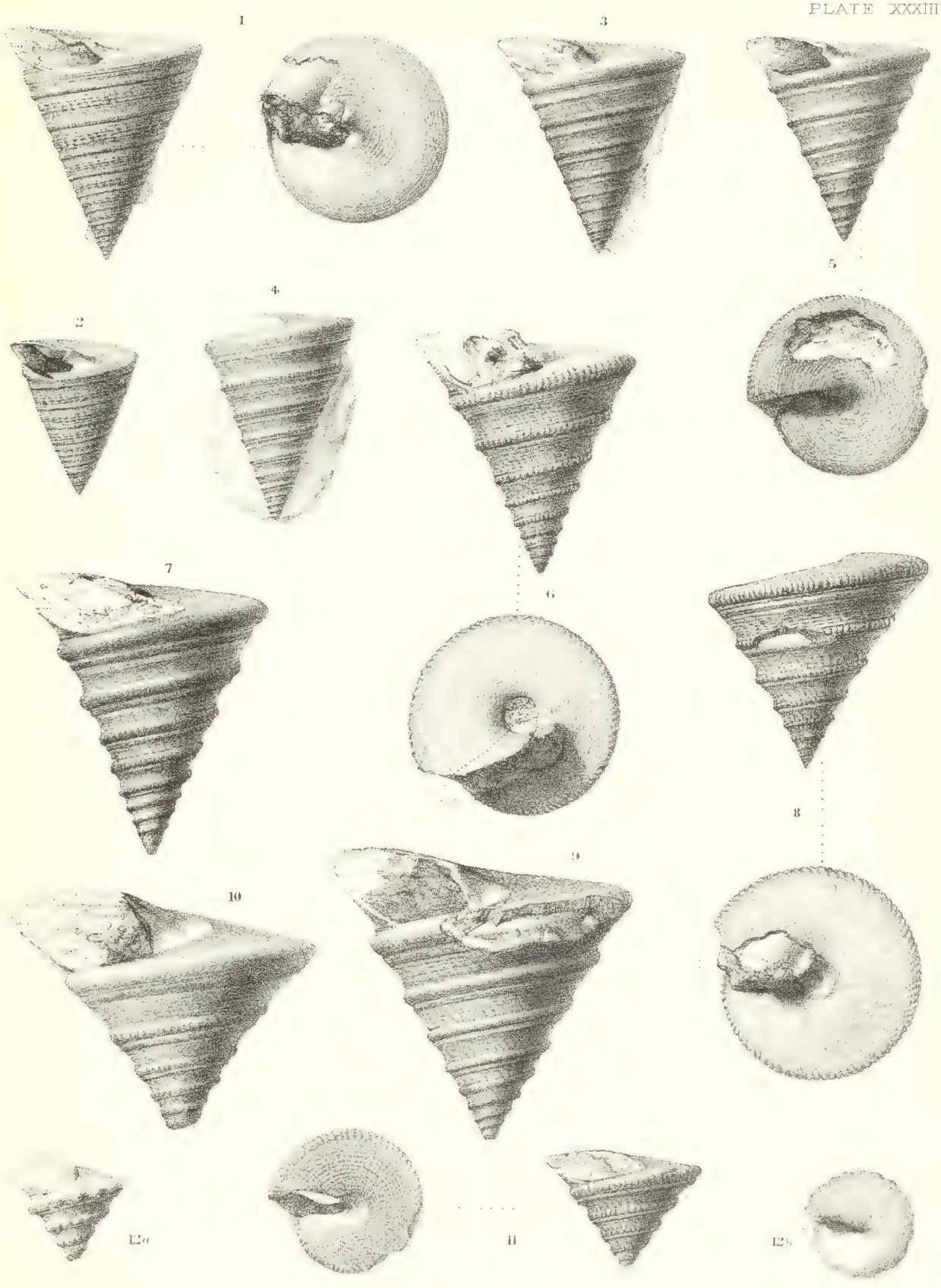
## PLATE XXXIII.

N.B.—*With reference to the* Pleurotomariæ *on Plates XXXIII to XL inclusive, it should be observed*—1. *That all figures are natural size unless otherwise stated.* 2. *All figures are from pencil drawings.* 3. *All specimens are from my own Collection unless otherwise stated.*

Fig.

1. *Pleurotomaria punctata,* Sowerby. Dundry. Front and base. (Page 396.)
2. The same. Small specimen. *Concavus*-bed. Bradford Abbas. Front.
3. *Pl. bicingulata,* sp. nov. *Concavus*-bed, Bradford Abbas. Front. (Page 398.)
4. *Pl. elongata*, Sowerby, var. *angusta.* Bradford Abbas. ? *Murchisonæ*-zone. Whidborne Collection. Back. (Page 399, *et seq.*)
5. *Pl. elongata*, Sow. Another variety. *Concavus*-bed, Bradford Abbas. Front and base.
6. *Pl. elongata*, Sow., var. near to *Pl. conoidea*, Deshayes. Louse Hill (*Humphriesianus*-zone). Front and base.
7. *Pl. elongata*, Sowerby. The type-form. Cf. *Pl. Pictaviensis*, d'Orb. *Sauzei*-bed. Neighbourhood of Sherborne (Combe). Front.
8. *Pl. abbreviata*, Sowerby. Usual form. *Sauzei*-bed, Oborne. Back and base. (Page 401.)
9. *Pl. abbreviata,* Sow. Smooth variety, analogous to *Pl. Pictaviensis* but wider, *Sauzei*-bed, Oborne.
10. *Pl. circumsulcata*, d'Orbigny. Dorset. ? *Parkinsoni*-zone. Front. (Page 404.) N.B.—The submarginal furrow in the base characteristic of this species cannot be identified in this specimen owing to wear of the surface.
11. *Pl. circumsulcata*, d'Orbigny. *Parkinsoni*-zone, Burton Bradstock. Back and front.

12 *a*, 12 *b*. *Pl. Agatha*, d'Orbigny. Small nodular form. *Parkinsoni*-zone, Broadwindsor. Front and base. (Page 402.) N.B.—This specimen, which differs considerably from the more recognised forms of *Pl. Agatha*, especially in the fulness of the base, is classed here provisionally.

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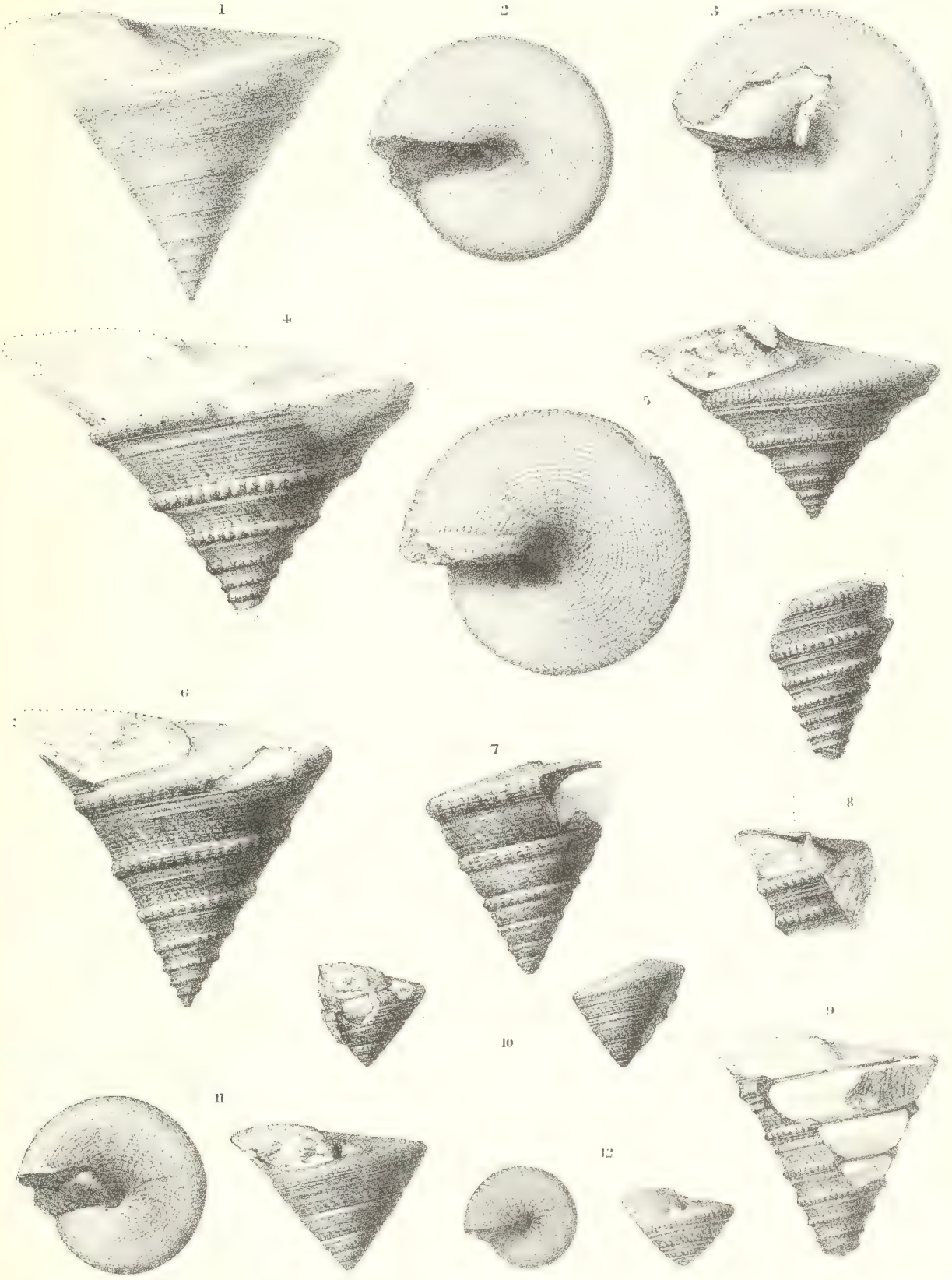
## PLATE XXXIV.

Fig.

1. *Pleurotomaria subglabra*, sp. nov. *Humphriesianus*-zone, Oborne. Front. (Page 405.)
2. Another specimen. *Humphriesianus*-zone, Oborne. Base.
3. *Pl. circumsulcata*, d'Orbigny. *Humphriesianus*-zone of the Sherborne district. Base. (Page 404.) N.B.—The spiral angle and general character of this specimen resemble fig. 10 on Plate XXXIII.
4. *Pl. Bessina*, d'Orbigny. *Parkinsoni*-zone, ? Halfway House. Nodular variety resembling the Normandy types. Front. (Page 406.)
5. Another specimen. *Parkinsoni*-zone, Burton Bradstock. N.B.—This is a small and rather depressed specimen of the variety most usual in the English beds.
6. *Pl. Agatha*, d'Orbigny. ( = *Pl. mutabilis*, var. *cœlata*, Deslong.) *Parkinsoni*-zone, ? Halfway House. Front. (Page 402.)
7. *Pl. Agatha*, d'Orbigny, var. *Sandersii*, Tawney. Dundry. Bristol Museum. Back. (Page 403.)
8. *Pl. elongata*, Sow., var. *turrita*, Deslongchamps. *Parkinsoni*-zone, Burton Bradstock. Back and front. (Page 401.)
9. *Pl. Obornensis*, sp. nov. Marl with green grains, Oborne. Front. (Page 404.)
10. *Pl. distinguenda*, Tawney. Dundry. Bristol Museum. Front and back. (Page 407.)
11. *Pl. Dundriensis*, Tawney. Dundry. Bristol Museum. Base and front. (Page 407.)
12. *Pl. Athulia*, d'Orbigny. Crewkerne Station, ? *Parkinsoni*-zone. Base and front. (Page 409.)

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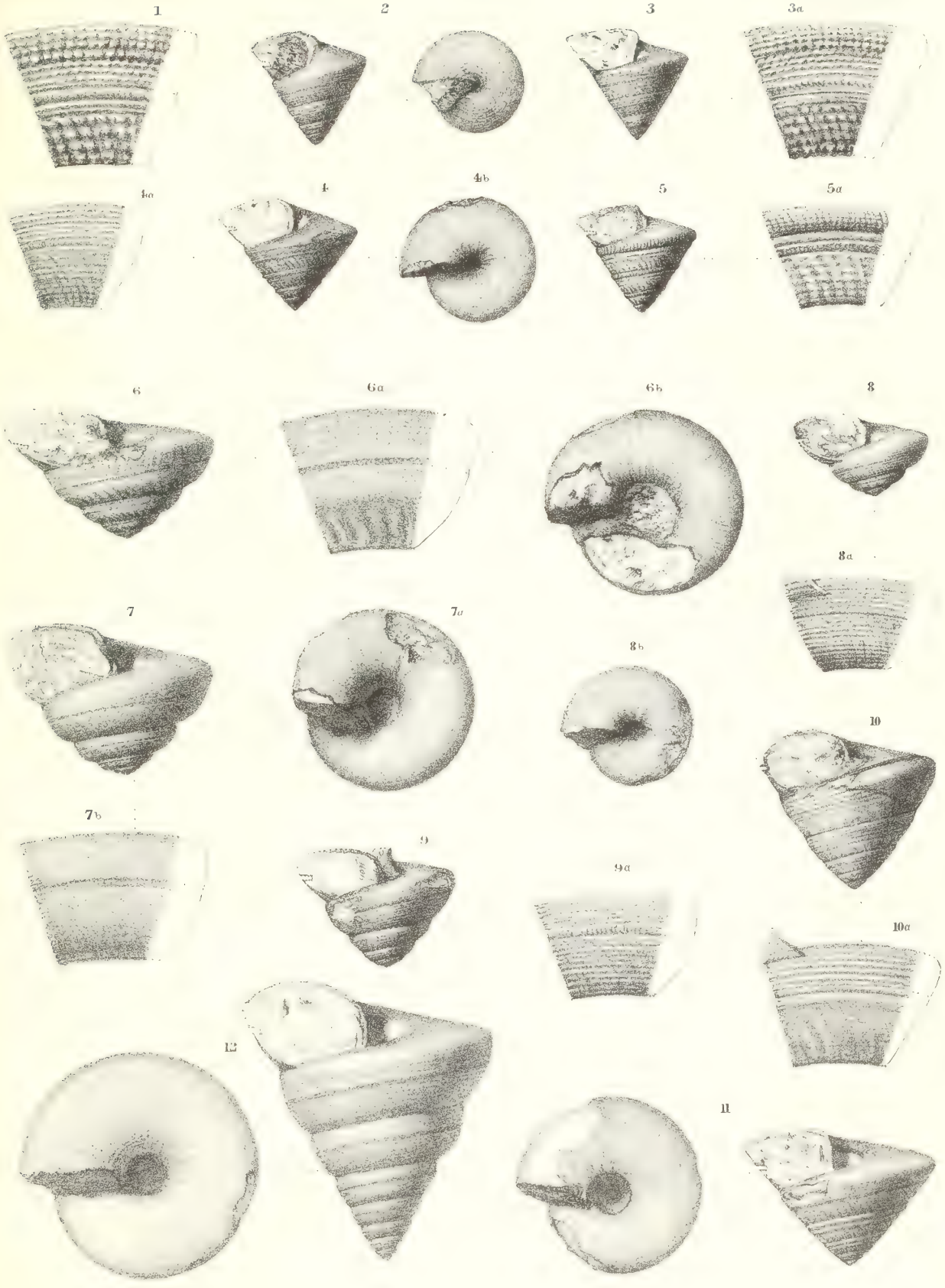
## PLATE XXXV.

Fig.

1. *Pleurotomaria distinguenda*, Tawney. Dundry. Bristol Museum. Portion of the type specimen enlarged. (Page 407.)
2. *Pleurotomaria*, species or variety. *Cadomensis*-bed, Clatcombe. Front and base. (Page 408.) ? A variety of *Pl. scrobinula*.
3. *Pl. scrobinula*, Deslongchamps. *Parkinsoni*-zone, Woolston. Front. 3 *a*. Portion enlarged. (Page 408.)
4, 4 *a*, 4 *b*. *Pl. Alcyone*, d'Orbigny. *Parkinsoni*-zone, Burton Bradstock. Front, enlargement and base. (Page 409.)
5. *Pleurotomaria*, species or variety. ? *Parkinsoni*-zone, Burton Bradstock. Front. 5 *a*. Portion enlarged. (Page 410.)
6, 6 *a*, 6 *b*. *Pl. sulcata*, Sowerby. Dundry. Front, enlargement and base. (Page 410.)
7, 7 *a*, 7 *b*. *Pl. sulcata*, Sow. Obconical variety. Cf. *Pl. obconica*, Tawney; cf. also *Pl. lævigata*, Deslongchamps. Irony nodule-bed, Burton Bradstock (*Murchisonæ*-zone). Front, base and enlargement. (Page 411.)
8, 8 *a*, 8 *b*. *Pl. Ajax*, d'Orbigny. *Murchisonæ*-zone, Lincoln. Front, enlargement and base. (Page 412.)
9, 9 *a*. *Pl. Ajax*, d'Orbigny. Obconical variety. *Murchisonæ*-zone, Lincoln. Front and enlargement.
10, 10 *a*. *Pl. monticuloides*, sp. nov. Haselbury. Front and enlargement. (Page 413.)
11. *Pl. sulcata-Humphriesiana*, sp. nov. *Humphriesianus*-zone, Louse Hill. Base and front. (Page 414.)
12. *Pl. Amyntas*, d'Orbigny. Irony nodule-bed, *Murchisonæ*-zone, Burton Bradstock. Base and front. (Page 415.)

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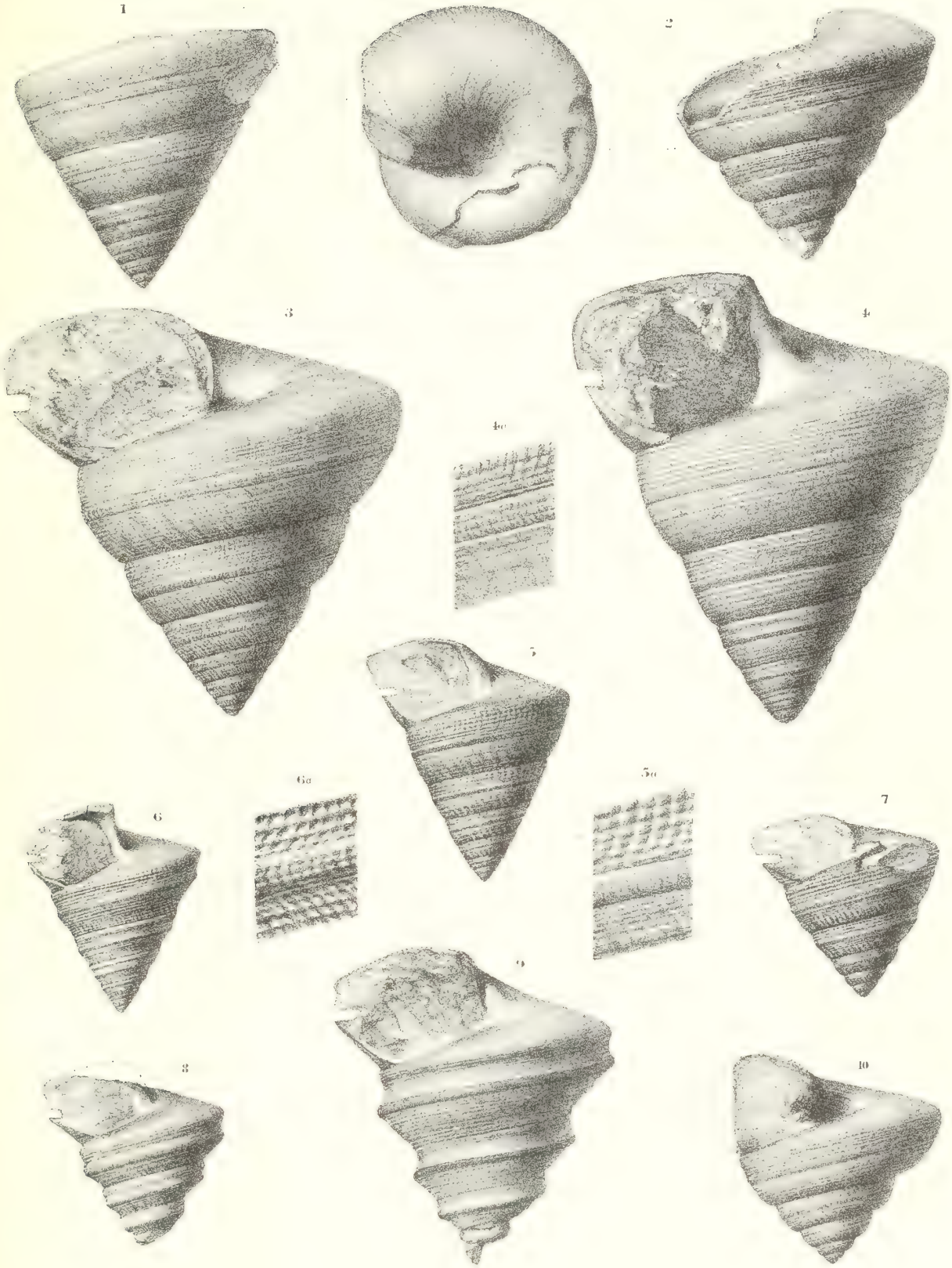
## PLATE XXXVI.

Fig.

1. *Pleurotomaria subplatyspira*, d'Orbigny. *Sauzei*-bed, Milborne Wick. Back. (Page 416.)
2. *Pl. Stoddarti*, Tawney. Dundry. Bristol Museum. Base and back. (Page 418.)
3. *Pl. fasciata*, Sowerby. Dundry. Front. (Page 416.)
4, 4 *a*. *Pl. transilis*, d'Orbigny. *Parkinsoni*-zone, Burton Bradstock. Front and enlargement. (Page 419.)
5, 5 *a*. *Pl. Allica*, d'Orbigny. *Humphriesianus*-zone, Louse Hill. Front and enlargement. (Page 422.) N.B.—Specimens more nearly resembling the type are associated.
6, 6 *a*. *Pl. subreticulata*, d'Orbigny. Mapperton, ? *Humphriesianus*-zone. Front and enlargement. (Page 422.)
7. *Pl. ? subreticulata*, d'Orb. Lincolnshire Limestone, Rauceby. Front. (Page 423.)
8. *Pl. textilis*, Deslongchamps. *Parkinsoni*-zone, Burton Bradstock. Front. (Page 424.)
9. *Pl. textilis*, var. *scalaris*, Deslongchamps ( = *Pl. scalaris*, var. *stricta*, Deslongchamps). *Parkinsoni*-zone, Halfway House. Front. (Page 425.)
10. *Pl.* cf. *subdecorata*, Münster. Dundry. Bristol Museum. Front. (Page 421.)

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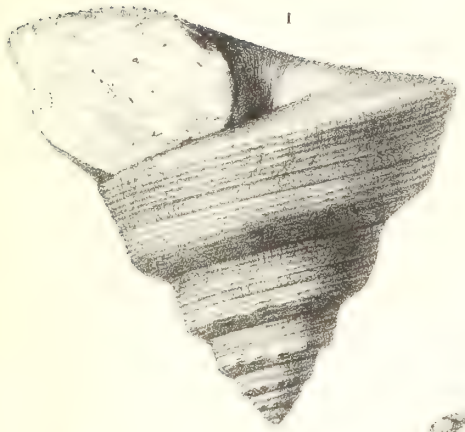
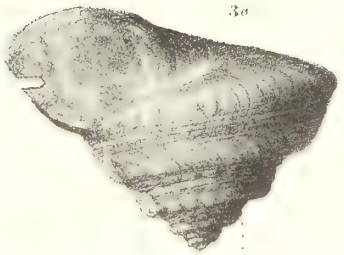
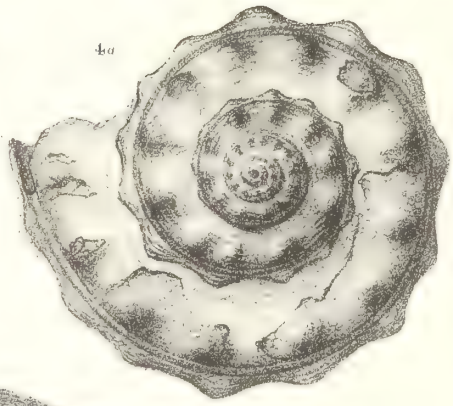
## PLATE XXXVII.

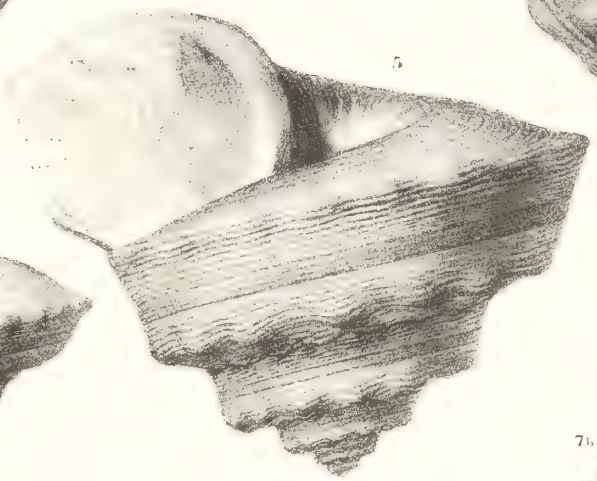
Fig.

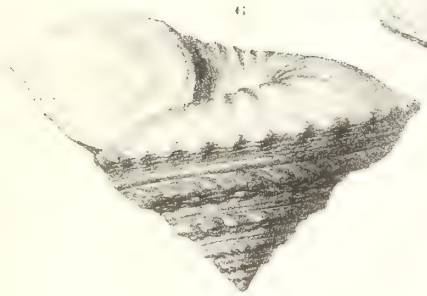
1. *Pleurotomaria paucistriata*, d'Orbigny. Iron-shot Oolite, Dundry. Bristol Museum. Front. (Page 425.)
2. *Pl. proteus*, Deslongchamps. *Humphriesianus*-zone, Louse Hill. Front. (Page 426.)
3 *a*—*c*. *Pl. ornata*, Sowerby. *Sauzei*-bed, Oborne. Front, apical and base. (Page 429.)
4 *a*, *b*. *Pl. tuberculosa*, Defrance. *Humphriesianus*-zone, Louse Hill. Apical, front. (Page 428.)
5. *Pl. armata*, Münster. Var. *Münsteriana*, Deslongchamps. *Parkinsoni*-zone, Burton Bradstock. Front. (Page 427.)
6. *Pl. oxytera*, sp. nov. *Sauzei*-bed, Sherborne district. Front. (Page 433.)
7 *a*, 7 *b*. *Pl. ? actinomphala*, Deslongchamps (acute variety). *Concavus*-bed, Bradford Abbas. Apical and base. (Page 433.)
8. *Pl. Actæa*, d'Orbigny. *Sauzei*-bed, Oborne. Front. (Page 431.)

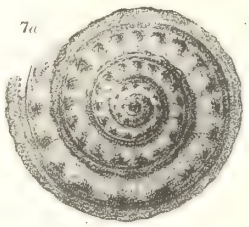


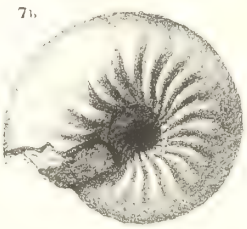


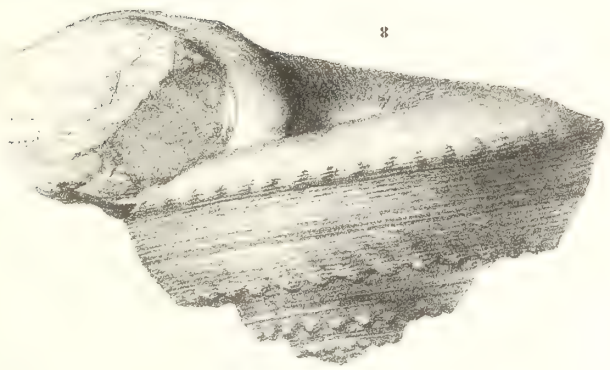


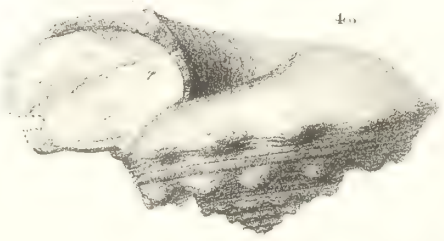












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## PLATE XXXVIII.

Fig.

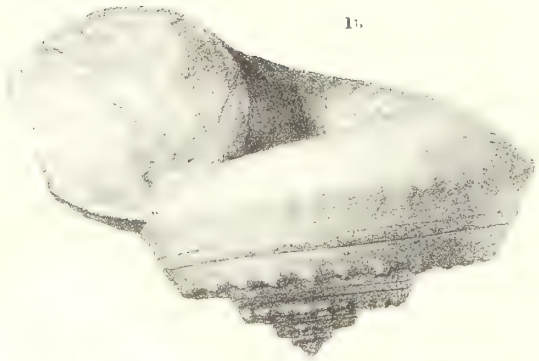
1 *a*, 1 *b*. *Pleurotomaria actinomphala*, Deslongchamps, var. *abbas* (obtuse variety). *Concavus*-bed, Bradford Abbas. Base and front. (Page 433, *et seq.*) N.B.—These figures represent two aspects of the fresh adult, where strong traces of the actinomphaloid character still remain.

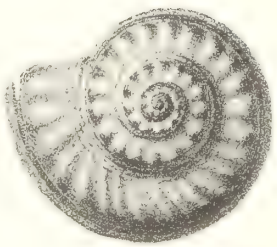
2. *Pl. actinomphala*, Deslongch., var. *abbas*. *Concavus*-bed, Bradford Abbas. Three aspects of the early stage of one of the more rugose forms.

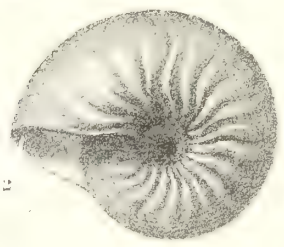
3. *Pl. actinomphala*, Deslongch., var. *abbas*. *Concavus*-bed, Bradford Abbas. Two aspects of the early stage of a smoother form, which is rare in the young shells.

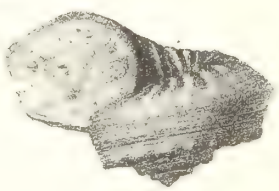
4 *a*, 4 *b*. *Pl. actinomphala*, Deslongch., var. *abbas*. *Concavus*-bed, Bradford Abbas. Two aspects of the last stage where the actinomphaloid character is entirely lost, and the shell is smooth in the base, growth-lines alone being visible.

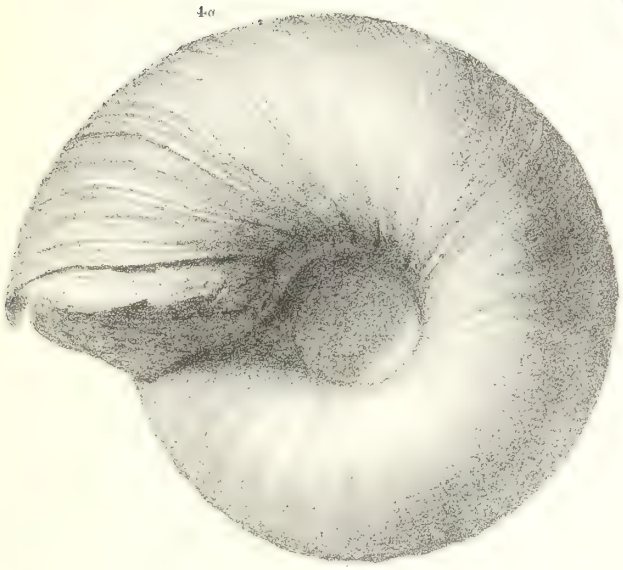
5. *Pl. actinomphala*, Deslongchamps (acute variety). *Concavus*-bed, Bradford Abbas. Base. (Page 434.)

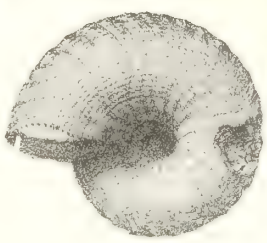


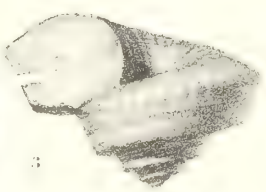



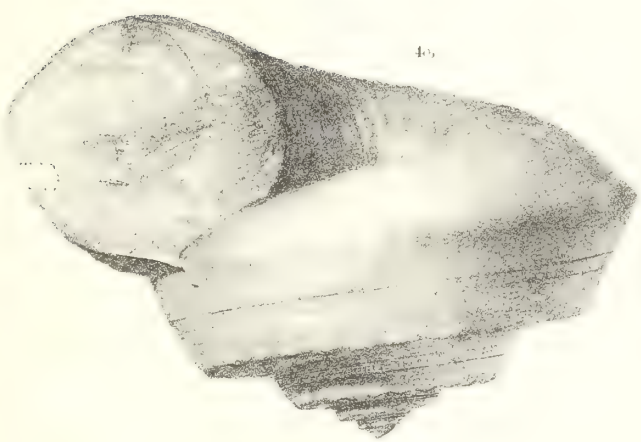






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## PLATE XXXIX.

Fig.

1 *a*, *b*. *Pleurotomaria subaraneosa*,. sp. nov. *Concavus*-bed, Bradford Abbas. Bristol Museum. Front and base. (Page 437.)

2 *a*, *b*. *Pl.* cf. *araneosa*, Deslongchamps. *Moorei*-beds, Buckholt Wood. Front and base. (Page 438.) N.B.—The umbilicus is not so large as shown in the figure.

3 *a*—*c*. *Pl. ornata-depressa*, sp. nov. (cf. *Cirrus carinatus*, Sowerby). *Concavus*-bed, Bradford Abbas. Apical, front and base. (Page 431.)

4 *a*—*c*. *Pl. Baugieri*, d'Orbigny. *Murchisonæ*-zone, Bradford Abbas. Front, apical and base. (Page 435.)

5 *a*—*c*. *Pl. Baugieri*, d'Orb., var. with higher spire and rather different ornamentation. (In some respects approaches *Pl. Aglaia*, d'Orb.) Most likely from the *Concavus*-bed at Halfway House. Front, base and apical.

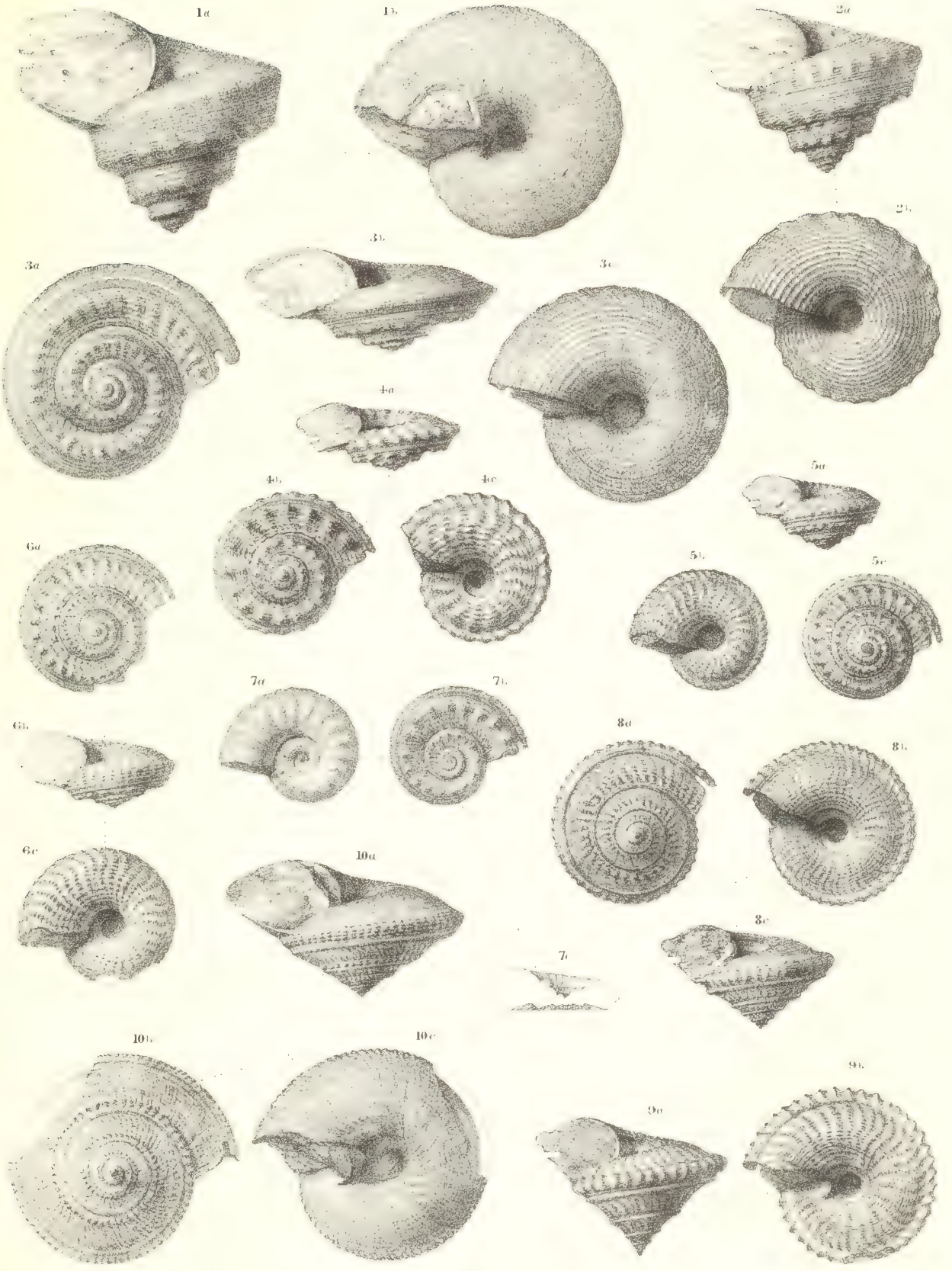
6 *a*—*c*. *Pl. Mopsa*, d'Orbigny. *Murchisonæ*-zone, Chideock. Apical, front and base. (Page 436.)

7 *a*—*c*. *Pl. mirabilis*, Deslongchamps (micromorph). Believed to come from the *Murchisonæ*-zone, Bradford Abbas. Base, apical and side. (Page 437.)

8 *a*—*c*. *Pl. Yeovilensis*, Tawney. *Concavus*-bed, Bradford Abbas. (Page 439.)

9 *a*, *b*. *Pl. Yeovilensis*, Tawney, var. *rugosior*. *Sauzei*-bed, Oborne. Front and base.

10 *a*—*c*. *Pl. granulata*, Sowerby. Depressed variety. *Sauzei*-bed, Milborne Wick. Front, apical and base. (Page 440.) N.B.—These figures of *Pl. granulata* are based on more than one specimen.

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## PLATE XL.

Fig.

1 *a*, *b*. *Pleurotomaria granulata*, Sowerby. (Elevated variety with coarse granulation = var. *cælata*, Deslong.) *Sauzei*-bed, Oborne. Front and enlargement. (Page 440.)

2 *a*—*c*. *Pl. plicopunctata*, Deslongchamps. *Parkinsoni*-zone, Burton Bradstock. Apical, base and front. (Page 442.)

3 *a*—*c*. *Pl. Palæmon*, d'Orbigny. *Parkinsoni*-zone, Vitney Cross. Apical, base and front. (Page 443.)

4 *a*—*d*. *Pl. phylax*, sp. nov. *Sauzei*-bed, Oborne. Apical, front, base, and enlargement. (Page 441.)

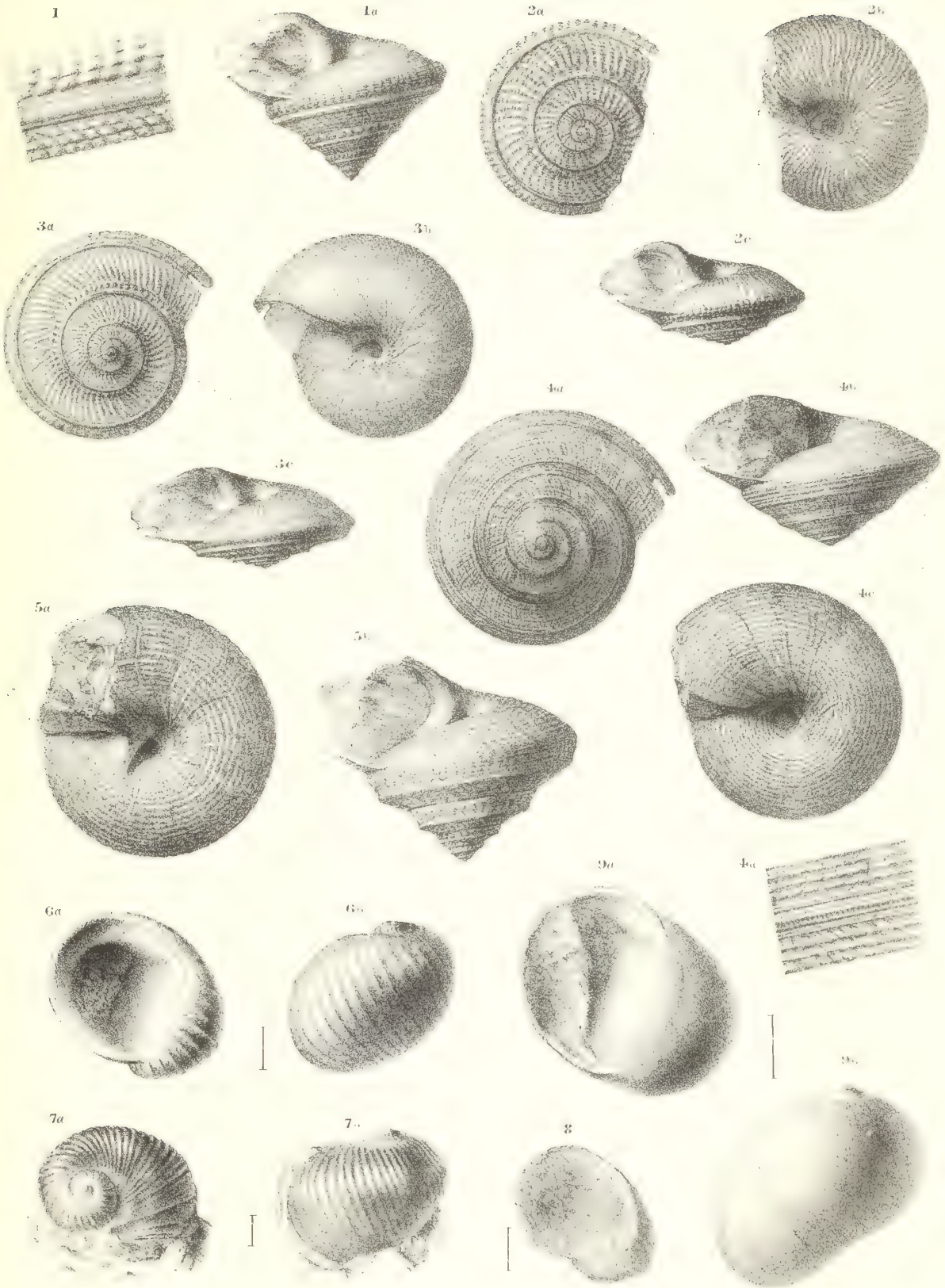
5 *a*, 5 *b*. *Pl. trapeza*, sp. nov. *Parkinsoni*-zone, Burton Bradstock. Base and front. (Page 444.)

6 *a*, 6 *b*. *Nerita costulata*, Deshayes. Pea-grit, Crickley. Front and back × 4 (Page 332.)

7 *a*, 7 *b*. *Nerita subrugosa*, sp. nov. Scarborough Limestone, Scarborough. Apical and back × 4. (Page 334.)

8. Another specimen. Northampton Sand, Duston. Front × 4.

9 *a*, *b*. "*Neritina subtransversa*." Oolite Marl of the Cotteswolds. (Page 336.)

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THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1895

LONDON

MDCCCXCV

A MONOGRAPH

ON

# CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.

PART II.

ANTHRACOMYA AND NAIADITES (ANTHRACOPTERA).

Pages 81—170; Plates XII—XX.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1895.

PRINTED BY ADLARD AND SON,
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17. Carbonicola elegans (*Kirkby*), 1880. Plate XX, figs. 12—15, 15 *a*.

Pleurophorus elegans, *Kirkby*. Quart. Journ. Geol. Soc., vol. xxxvi, 1880, p. 586, "On the Zones of Marine Fossils in the Calciferous Sandstone Series of Fife."

*Specific Characters.*—Shell transversely produced, cylindrically curved, not exceeding 25 mm. in length. The anterior end is small and much narrower dorso-ventrally than the rest of the shell. Its border is rounded in front, but hollowed out above by the lunule; it passes imperceptibly into the lower border, which is almost straight in direction, but posteriorly it rises very gently towards the posterior inferior angle. Its posterior border is rounded, the upper slope being more rapid than the inferior, and the postero-inferior angle is the most posterior part of the shell. The hinge-line is formed of two portions which meet at an obtuse angle posterior to the beak of the umbo. The upper border of the shell is swollen.

The umbones are broad and obtuse, rising gradually from the surface of the shell without any ridge anterior or posterior, but in front they are excavated by the lunule; they are situated about the junction of the anterior and second fourths of the length of the shell. The beaks are small, but curved over and pointed downwards and forwards, and terminate close to the hinge-line. The lunule is comparatively broad, and well marked. The whole shell is regularly swollen, more so above, and the valves have a rapid curvature from above downwards. The dorsal slope is somewhat flattened, and is always above the articulating hinge-line; the inner edge of the superior border is bevelled at the expense of its upper portion, forming with the opposite valve a V-shaped trench in the centre of which the valves articulate, and on either side of this articulating line is a longitudinal groove for the external ligament.

*Interior.*—The anterior adductor scar is almost marginal, deep and circular, the deepest part of the scar being at the upper and posterior part. The accessory adductor scar is placed above and internal to the anterior adductor; a strong umbonal rib bounds the anterior adductor behind. The posterior adductor scar is situated far back, just within the postero-superior angle of the shell; it is shallow and inconspicuous. The pallial line is simple, dotted, remote from the margin of the shell. Between the hinge-line and the superior border is a longitudinal groove in casts to receive the edge of the shell. Very obscure radiating lines are seen on the surface of casts. The hinge is a simple form of the type which obtains in *Carbonicola aquilina*. There are no anterior or posterior lateral teeth, but the edges of the hinge-line are bevelled below the umbo, the left valve being bevelled at the expense of its lower edge, to form a hinge.

*Exterior.*—The shell is ornamented with distinct but fine lines and striæ of growth somewhat oblique to the long axis of the shell.

*Dimensions.*—Fig. 15, Pl. XX, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 20 mm. |
| Dorso-ventrally . . . . | 10 mm. |

*Locality.*—Lower Cement-stone series, Fife; Limestone No. 10, at Randerstone, in a three-inch band of calcareous ironstone in light-grey sandy slate; in cliffs east of Pittenweem.

*Observations.*—This species was described by Mr. Kirkby, in his careful and accurate paper on the Marine Zones of the Calciferous Sandstone Series of the Fifeshire coast, under the name of *Pleurophorus elegans*, the generic name being given on the authority of Prof. de Koninck. He has kindly lent me a series of his fossils for study, and I have been able to examine the hinges and casts of the interior, with the result of coming to the conclusion that his shell belongs to the genus Carbonicola. The form of the hinge is practically identical with the type found in *Carbonicola aquilina*, and this differs markedly from the form found in Pleurophorus, which King states (Palæontographical Soc. vol. for year 1849, "Permian Fossils," p. 180): "Cardinal teeth two in each valve, diverging inwardly, and interlocking alternately; posterior teeth linear." Moreover, the species under discussion does not possess externally the radiating ribs on the posterior slope nor the characteristic shape, wider in a dorso-ventral direction posteriorly, which are to be seen in Pleurophorus.

*Carbonicola elegans* possesses characters which also are found in the other species which occurs in the Calciferous Sandstone Series, *C. antiqua*. The bevelled inner edge of the posterior border and other hinge peculiarities are similar in both, but there is no doubt that they are not the same species, differing so markedly from each other in shape and form.

Mr. Kirkby describes a faint diagonal ridge running from each umbo towards the postero-ventral angle, which I have been unable to make out in any of the specimens sent me, but otherwise his description is very accurate.

The shell more closely resembles *C. aquilina* than any other species, having in common with it the lines of growth arranged obliquely to the long axis of the shell, and the upper border of the anterior end being much below the level of the umbones; also the hinge characters are very similar; but *Carbonicola elegans* is more cylindrical, and has its umbones curved inwards, downwards, and forwards.

In the same beds with *C. elegans* only one other Mollusc is found, *Littorina Scotoburdigalensis*, but *Leperditia Okeni*, var. *attenuata*, and *Cytherella* also occur—a very similar fauna to that which accompanies *C. antiqua;* and it is very noticeable that the typical marine forms so abundant in the other shell-beds of the Fifeshire coast are conspicuously absent. With regard to the shell called

Littorina, the real generic affinities of which have never been accurately made out, Mr. Kirkby writes me that "latterly Mr. R. Etheridge, jun., thought it might be nearer Paludina." He goes on to say: "This little univalve, however, occurs sometimes with Murchisonia, Macrocheilus, and Schizodus, which are good types of marine Mollusca, besides with Bairdia, Kirkbya, Cytherella, and Leperditia, which are just as good genera of marine Ostracoda; and moreover at other times it is found with species of Carbonia, which is the most non-marine of all the Carboniferous Ostracoda." On the whole, the evidence as to the nature of the deposit is somewhat uncertain and unsatisfactory, but I am disposed to value the absence of typical marine Mollusca to a greater extent than the presence or absence of genera of Ostracods, whether marine or not.

## *Genus* Anthracomya, *Salter*, 1862.

*Synonyms:*

*Unio*, Williamson, 1836.
— Phillips, 1839.
— Prestwich and Sowerby, 1834–36.[1]
— Goldfuss, 1838.
*Anodonta*, Eichwald, 1840.
*Mytilus* (*Modiola*), Murchison, de Keyserling, and de Verneuil, 1845.
*Unio*, Morris, 1843, 1854.
*Cardinia*, de Ryckholt, 1849.
*Mytilus*, de Ryckholt, 1849.
*Modiola*, Brown, 1849.
*Unio*, Brown, 1849.
— Bronn and Römer, 1852–54.
*Modiolopsis* (*?*), Eichwald, 1855–59.
*Naiadites* (*pars*), Dawson, 1860 and 1878.
*Anodonta*, Ludwig, 1861.
*Anthracomya*, Wardle, 1862.
*Unio*, Ludwig, 1863.
*Cyrena* (*Cyclas*), Ludwig, 1863.
*Pleurophorus*, Meek and Worthen, 1866.
*Anthracosia*, Geinitz, 1867.
*Modiola*, Römer, 1870.
*Anthracomya*, R. Etheridge, jun., 1877.
*Anthracosia*, Kinahan, 1878.
*Myacites*, Kinahan, 1878.
*Anthracosia*, Baily, 1881.

[1] This paper was read on February 5th, 1834, and April 15th and 27th, 1836, though the publication bears the date 1840.

*Myacites*, Baily, 1881.
Non *Anthracomya*, Hull, 1881.
*Anthracosia*, Achepol, 1880–83.
*Anodon*, Achepol, 1880–83.
*Naiaditis*, Barrois, 1882.
*Anthracomya*, Ward, 1890.
— Hind, 1893.

*Generic Characters.*—Shell transverse, slightly inequivalve, very inequilateral, the anterior end being small and rounded, while the posterior is produced, compressed, expanded, and generally truncate. The umbones are small and low, situated near the anterior end, very slightly raised above the hinge-line, which is straight, long, and with a cardinal and one long posterior lateral tooth in at least one species. It has a narrow interior ridge, parallel with the edge, in its posterior portion, which leaves a groove in casts. There is present a blunt oblique swelling, which arises at the umbones, and expanding as it passes downwards and backwards, becomes lost on the posterior portion of the shell. Parallel and anterior to the ridge there is an oblique shallow sulcus, which becomes expanded as it approaches the inferior margin. The ligament is small, erect, and external.

*Interior.*—Nacreous, smooth; pallial line simple. Anterior adductor scar deep, almost marginal, that of the accessory adductor situated above and posterior to it. The posterior adductor scar is shallow and somewhat elongate, generally situated on the posterior slope not far from the hinge.

*Surface.*—The exterior is ornamented with fine lines of growth and a much wrinkled periostracum.

*Observations.*—Although Mr. Salter does not mention the fact, figures and descriptions of shells belonging to his genus Anthracomya had been given by many authors besides Sowerby, to whom alone he refers. As far back as 1836 Dr. W. C. Williamson described a shell from the Spirorbis Limestone of Pendlebury as *Unio Phillipsii* ('Phil. Mag.,' vol. ix, p. 351), which undoubtedly belongs to this genus. Continental writers never seem to have recognised Salter's genus, though several species have been described under other generic names; but this is no doubt due to the fact that apparently few of these shells are to be obtained in the coal-fields of Europe, if one may judge by the public collections; and, although three forms—*Anthracomya carbonaria* (Bronn), *Anthracomya uniformis*, Goldfuss (generally found to be named, after de Koninck, *Goldfussiana*), and *Anthracomya minima*, Ludwig (with which the *Modiola Carlotta*, Römer, is synonymous)—are of frequent occurrence, I do not know of the presence in Great Britain of any but the last.

Mr. Salter himself, when establishing the genus, as is shown by the derivation of the name, thought that the shells he was describing had a close affinity to the Myas or burrowers of our sea-shores, and referred his new genus to the family

Myadæ; and under his observations on *Anthracomya senex* says: "We cannot get at the interior, but there is not much doubt there is a pallial sinus; and there were probably long siphonal tubes covered by a thick epidermis, the animal burrowing in the mud as most Myadæ do."[1] It is difficult to see why such a relationship should be so strongly insisted upon in the absence of direct evidence, but Mr. Salter held the view that the Coal-measures were a marine deposit, consequently the palæontology had to be fitted in to suit this opinion.

The characters on which Mr. Salter probably most strongly relied for the reference of these shells to the Myadæ are the occasional gaping of both ends (but this is not at all of constant occurrence, even in the same species) and the V-shaped markings on the type specimen of *Anthracomya senex*. He says, speaking of the shells for which he is proposing a new name (p. 230, op. cit.): "For these the discovery of a common character in the epidermis at length enables me to propose a generic name;" but beyond stating that the epidermis is wrinkled, he did not in any way say what this common character was. These markings in *A. senex* are to a large extent accidental and not specific, and this fact will be further noted under observations on this species (p. 111). But a V-shaped arrangement of the periostracum is to be found in some members of the Unionidæ[2] from abroad, and is therefore in no way peculiar to the burrowing Myacidæ. The absence of a pallial sinus, the simple Unio-like type of hinge-line, erect external ligament, absence of an internal cartilage, the position and shape of the adductor muscles, and the thickened periostracum, all point rather to a connection with the Unionidæ. In common, however, with Carbonicola, Anthracomya has the accessory adductor scars situated above and posterior to those for the anterior adductors, and not, as in recent Unionidæ, below and posterior to them.

In shape the Anthracomyæ approach the genus *Tridina* (*Mutela*) but are distinguished by the absence of the multidenticulate hinge.

There is little evidence to be obtained in favour of the view that the Anthracomya were burrowers. They are very seldom found at right angles to the stratification of the beds in which they occur, but nearly always lie parallel to them; and, further, they are always associated with byssiferous Naiadites which could not have lived buried in the mud.

All the early writers referred the shells, subsequently grouped under the name Anthracomya, to Unio, Ludwig recognising the close resemblance to Anodon by referring several forms to this genus, with which there are strong resemblances in shape and hinge-structure; but there are certain marked differences, the umbones

[1] 'Mem. Geol. Surv. Great Britain;' 'Iron Ores of Great Britain,' part iii; 'Iron Ores of South Wales,' 1861, p. 231.

[2] For example, the species named *Unio Vignonianus*, *U. Kleinianus*, and *Anodonta rugifera* in the Collection of recent shells in the Natural History Museum, South Kensington.

in Anthracomya being well developed compared with those in Anodon, and as far as my observations go, are never eroded. The accessory adductor muscle, too, has a different position. I have never been able to make out that Anthracomya possessed a byssus, though, in all species, the valves have a well-marked oblique sulcus and a sinuated inferior border, indicating the connection with a byssiferous ancestor, or that they themselves were byssiferous in the fry. D'Orbigny quotes a byssiferous form of Anodon, being found in the river Paraná, South America.

In my paper on the affinities of this genus in the 'Quarterly Journal of the Geological Society' (vol. xlix, 1893, p. 258), on similar grounds to those advanced here, I contended for the replacement of this genus in the family Unionidæ; but I was not aware at that time of the extent of the literature of the subject, as may be noted by the number of synonyms given.

De Ryckholt ('Mélanges Paléontologiques,' 1848) appears to have referred some forms of Anthracomya to Cardinia (Agassiz); but great uncertainty prevails about de Ryckholt's type-forms, which I am unable to trace; Professor Dewalque, of Liège, kindly showed me his collection and pointed out forms which he had named after de Ryckholt from the same localities whence the originals were obtained. In looking through the collection in the Brussels Museum I found typical Anthracomya labelled as Cardinia and Mytilus after de Ryckholt. From Mytilus, Anthracomya can easily be distinguished by the absence of the triangular, wedge-shaped form, the non-terminal position of the umbones, the absence of the scars for the byssal muscles, and the erect external ligament. Indeed, Anthracomya approaches far more closely to Modiola, to which genus Brown ('Fossil Conch.,' 1849, p. 172, pl. lxxi, figs. 24, 25; pl. lxxii, figs. 19, 20, 24, 25, 27, 29) and Römer, 1870 ('Geologie und Paläontologie von Oberschlesien,' p. 76, foot-note), refer typical shells; but Anthracomya has not the inflated anterior portion, internal ligament, byssus, or muscle-scars of Modiola, and the form and position of the umbones in either genus is markedly different. Anthracomya possesses a well-marked lunule, a character absent in the family Mytilidæ. From the sub-genus Modiolopsis, to which shells having the typical appearance of Anthracomya are referred by Eichwald, the same characters will serve as a means of separation.

Sir W. J. Dawson proposed the name Naiadites for certain Coal-measure Lamellibranchs from Nova Scotia ('Acadian Geology,' p. 43, 1860), but Mr. Salter pointed out that the group contained members of more than one genus ('Quart. Journ. Geol. Soc.,' vol. xix, 1863, p. 80), some of which he correctly referred to his new genus Anthracomya (see also 'Quart. Journ. Geol. Soc.,' 1894, vol. l, p. 437, *et seq.*; and *antea*, pp. 25, 26, and 27).

Ludwig proposed at least three names for members of the genus under notice, two of which—Unio and Anodon—need not be more than mentioned here; but it

is necessary to point out in what manner the characters of Cyclas (Cyrena) differ from Anthracomya.

Cyclas is suborbicular in shape, nearly equilateral, and possesses as dentition cardinal teeth 2—1, lateral teeth 1—1 : 2—2; while Cyrena has three cardinal teeth and a slightly sinuated pallial line.

The shell figured as Pleurophorus by Meek and Worthen ('Geol. of Illinois,' pl. xxvii, figs. 2, 20, p. 347) has all the appearances of *Anthracomya Williamsoni* (Brown). In the figure the position of the accessory-anterior-adductor scar is well shown, and the authors remark on the different situation of this scar in King's Pleurophorus. "It evidently differs from that species [*Pleurophorus costatus*, Brown, from the Permian] in having the scars of its pedal muscles nearly marginal and placed *directly over* those of the anterior adductors, instead of partly behind them." The surface of casts is said to show "traces of a few obscure concentric markings crossed on the posterior dorsal region by three obscure radiating costæ"—a character well seen in *Anthracomya Williamsoni*. The description and figures are perfectly typical, and I have no doubt as to the nature of the shell.

The palæontologists of the Irish Geological Survey did not accept Mr. Salter's genus Anthracomya, but referred their specimens to Anthracosia and Myacites. The Irish specimens are unfortunately not in the best state of preservation, but they exhibit characteristic features and are separated from Myacites at once by the absence of a sinuated pallial sinus.

Anthracomya and Carbonicola (the Anthracosia of previous writers) are no doubt closely related, but they are easily distinguished from one another by the absence, in Anthracomya, of the characteristic hinge-plate or hinge-teeth of Carbonicola, and by the typical expanded and broad posterior end which always obtains in this genus. It is noteworthy that a large number of Lamellibranch shells occurring with an undoubtedly marine fauna in Carboniferous rocks possess this last character; I refer to the genus now known as Sanguinolites, and this genus has the accessory-pedal muscle scars in the same situation as obtains in Anthracomya. I consider that the Anthracomyæ possess a set of characters which is an approach nearer to the Mytilidæ than Carbonicola, which again is intermediate between the Anthracomyæ and the modern Unios.

The position of the accessory-adductor muscle-scar in both Carbonicola and Anthracomya has rather a Mytiliform arrangement, more than occurs in recent Unionidæ. The traces of an obsolete byssal sinus in Carbonicola, more conspicuous also in Anthracomya; the tendency in the species of Carbonicola to have a truncate posterior end, and the universal occurrence of an expanded and truncate termination, with an oblique diagonal ridge, in Anthracomya; the longitudinally striated lunule and tooth-socket in Carbonicola,—all seem to show

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along what lines the modern Unio has developed from a Mytiliform ancestor. Mycetopus from the Paraná and Amazon retains the edentulous hinge, expanded posterior end, and subparallel margins which are so characteristic of Anthracomya; Anodon also has a very strong external resemblance, but I have never seen the erosion of the umbones in any species of Anthracomya. The Anthracomyæ are, as a rule, comparatively rare, and form a very small percentage of the molluscan remains at any horizon, although in one or two beds one species may occur abundantly, in which case other shells are very seldom found. They had not, with the exception of *Anthracomya Phillipsii*, the gregarious habit of Carbonicola and Naiadites. The members of this genus are, as far as is known at present, absent in the Upper Coal-measures, with one exception, *A. Phillipsii;* and are chiefly found in the Middle Coal-measures of Lancashire, Yorkshire, and the Midlands; in Scotland, one species (*A. Scotica*) occurs in the Calciferous sandstone beds, and another (*A. modiolaris*) is found in beds of the Carboniferous limestone group, and also in those of the true Coal-measures. The so-called Lower Coal-measures of North Staffordshire really belong to the middle division, the Gannister series being represented in this area by the lower beds only of the Biddulph and Cheadle basins, where alone the fossils characteristic of the Yorkshire and Lancashire gannister are to be found. In North Staffordshire an arbitrary line is taken at the Ash or Rowhurst coal, which is said to be at the top of the Lower Measures; but there is neither lithological nor palæontological ground for this division, which should be placed, I think, more correctly, if anywhere, above the Bulhurst seam, where shales with Aviculopecten, Goniatites, Lingula, and Posidonia occur in the Pottery coal-field, and at the Stinking coal shale of the Cheadle coal-field, where a similar fauna is also to be found. Even in Lancashire, beds full of Carbonicola are to be found in the Lower or Gannister Coal-measures.

In a letter last year, Mr. Kirkby drew my attention to the close resemblance between Portlock's *Modiola Macadami* and its two varieties, and *M. subparallela*, and the shells of the genus Anthracomya. I figure two specimens, kindly lent me by Mr. Wright, of Belfast, from the Coal-measures of Ballycastle, on Pl. XVII, figs. 1 and 2, which seem to be characteristic of the form known as *Modiola subparallela*, which Portlock states in his observations also merge into *M. Macadami*. The original figure approaches very closely in contour to some forms of Anthracomya, while *M. Macadami*, especially the variety *elongata*, would seem to resemble *Anthracomya Phillipsii*. Portlock, however, goes on to say this variety approximates to *M. lingualis*, Phillips, a Mountain-limestone form. The Irish specimens occur in beds of shale with large scales of *Holoptychius Portlocki*, now *Archichthys* (*Strepsodus*) *Portlocki*.

1. Anthracomya Adamsii, *Salter*. Plate XII, figs. 1—19.

Anthracomya Adamsii, *Salter*. Geol. Surv. Mem. Iron Ores S. Wales, 1861, p. 230, pl. ii, figs. 7, 7 *a*, 7 *b*.

Non — — *Ward*. North Staff. Inst. Min. and Mech. Engineers, vol. x, 1890, p. 125, pl. i, fig. 2.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 260, pl. viii, figs. 5, 5 *a*, 6, 7, 8.

*Specific Characters*.—Shell equivalve, obliquely and triangularly ovate, compressed all round the borders, and produced posteriorly. The anterior end is short, narrow in depth, only slightly convex, with a straight superior margin and a rounded border, the antero-superior angle being a rounded right angle. The inferior border descends rapidly, being at times slightly situated anteriorly; otherwise the outline is more or less convex. The posterior end is flattened and expanded, with a more or less truncated border. The hinge-line is straight, extending nearly the whole of the length of the shell; its umbones are broad, tumid, contiguous, raised above the hinge-line, situated in the majority of cases at about a point equal to two-fifths of the length of the hinge-line from the anterior end. The posterior slope is much compressed, and produced upwards. An oblique obtuse swelling passes diagonally backwards and downwards from the umbo, and soon becomes lost on the surface of the shell, anterior to which is an almost obsolete broad sulcus. The lunule is elongate and narrow. The cartilage is external, very small and erect. The hinge-line has not yet been observed.

The *interior* is smooth; muscular scars normal in position and arrangement.

The *exterior* is marked with fine excentric lines and folds of growth, which are crowded together at the anterior end, but diverge slightly as they pass across the shell, becoming parallel to the lower margin, the curvatures increasing in strength as they approach the posterior end, where they are reflected upwards to terminate in the superior border. Obsolete radiating lines are often seen on the posterior slope. Periostracum strongly wrinkled, shell thin.

*Dimensions* (Pl. XII, fig. 1):

| | |
|---|---|
| Antero-posteriorly . . . . | 65 mm. |
| Dorso-ventrally . . . . | 45 mm. |
| Laterally . . . . . | 10 mm. |

*Localities*.—Soap vein, Pen-y-cae, South Wales. Little Mine ironstone of Fenton and Longton, which is the same bed known as the New Mine, or Burnwood, of the more northern part of the North Staffordshire Coalfield. Horsleywood seam, Northumberland.

*Observations*.—Like other Coal-measure shells, the shape of *Anthracomya Adamsii* is not very constant even locally. The whole of the specimens of this

shell figured are from the Little Mine ironstone of Great Fenton Colliery, and may be regarded as typical of the various forms which the shell was capable of assuming. The chief points to be noted are the differences in the comparative measurements, and in the shape of the posterior end, which becomes in some specimens almost square (Pl. XII, figs. 6 and 9).

In my paper ('Quart. Journ. Geol. Soc.,' vol. xlix, 1893, p. 260) I made the statement that the left valve was slightly more convex than the right, a fact which I now believe to have been due to some slight dislocation of the valves after death, for the examination of a larger number of specimens has convinced me that this character was only accidentally present. Mr. Salter stated that the right valve was more convex. I have seen very few specimens indeed which afford any indications of the hinge or interior. Fig. 3, Pl. XII, however, shows a very thin hinge-line; and fig. 4, Pl. XII, is a cast of the hinge and part of the interior. The line which indicates in this specimen the junction of the valves is perfectly straight, and exhibits no flexures. In front, too, are seen on either side the accessory adductor muscle-scars, which unfortunately the artist has not indicated quite strongly enough. Some specimens (Pl. XII, figs. 3 and 10) show well-marked colour-bands.

Mr. Salter (*op. supra cit.*), in his remarks on this species, says, "A very much compressed species, with the look of a smooth Myacites—to which, in fact, it is allied;" but he does not go any further into details. The type specimen is somewhat smaller than the majority of those figured on Pl. XII, and has the subtruncate posterior end of figs. 6, 9, and 12.

Mr. Salter states that the "epidermis is moderately wrinkled in front, much so posteriorly;" but this is not a constant fact, the opposite condition obtaining in fig. 17, Pl. XII, and in fig. 19, Pl. XII, the greatest amount of wrinkling being over the central part of the shell, and the position is evidently quite accidental. With regard to the change of shape due to growth, I have figured what I take to be young forms, Pl. XII, figs. 14, 15, 16, and 13. Fig. 14 indicates the very young state, and this form occurs in large quantities with even smaller specimens, as a sort of spat bed in the Burnwood ironstone shale of Goldenhill. Figs. 13, 15, and 16 are from the same bed as the larger specimens. From a study of these it would appear that the posterior part of the shell enlarges with age at a greater rate than the anterior end, and a similar condition of growth obtains in other species of the genus. The adult form of this shell is by far the largest of all the species of this genus, and though occurring plentifully locally it is only found in the Soap vein of Pen-y-cae, South Wales Coal-field, and the Burnwood ironstone and black shale immediately above it, in the North Staffordshire Coal-field.[1] I

[1] In 'Geol. Surv. Mem. Iron Ores of Great Britain,' part 4, p. 294, *A. Adamsii* is stated to have been obtained with *A. pumila* and *A. centralis* from the Knowles Shale of Fenton and Longton, but I

know of one specimen from the Horsleywood seam of the Northumberland Coal-field. I have not met with the form in European collections. It is limited to one horizon both in South Wales and North Staffordshire. The shells are usually in a good state of preservation, and have both valves attached, showing that they are in the place where they lived. They evidently had no byssus, as they are never attached to each other or to drift-wood, and they lie chiefly parallel to the bedding planes.

The smallness of the external ligament is very remarkable, the whole of it, as shown in fig. 9 *a*, Pl. XII, only measuring 12 mm., the length of the whole hinge-line being 57 mm. Posterior to the ligament the valves came in contact, much thinned and expanded upwards. This part of the shell is very delicate, and is not often seen, owing to the difficulty of extraction from a very hard matrix.

The shell was exceedingly thin all over, and in many of the figured specimens has disappeared from the umbones; but this is accidental, and not in any sense due to erosion. It would appear from the longitudinal grooves on either side of the cast of the hinge-line that in front and for about half the length of the hinge-line posterior to the umbones the edge of the shell was produced downwards or turned on itself at a right angle to form a hinge-plate, but this must have been absent at the posterior end; and it will be noticed in fig. 4, Pl. XII, that the grooves gradually become obsolete as they pass backwards. It is probable that there is a long posterior lateral tooth in that part of the hinge-line which occupied the grooves. This gradual thinning away of the hinge-plate obtains also in the other species of this genus in which I have been able to procure casts, and is somewhat analogous to the formation of the hinge-plate in *Sanguinolites iridinoides*, M'Coy.

In addition to specimens having a comparatively elongate shape, there is a form of *A. Adamsii* which is of such constant occurrence that I considered it well in my paper in the 'Quart. Journ. Geol. Soc.' to give it a varietal name. I still adhere to this opinion, though a series of intermediate forms are to be found. This form was figured by Mr. Ward (*op. supra cit.*) under the name of *A. Adamsii*, but the shape and position of the umbones differ considerably from those of the type.

1*. ANTHRACOMYA ADAMSII, var. EXPANSA, *Hind.* Plate XIII, figs. 1—3.

ANTHRACOMYA ADAMSII, *Ward.* Trans. N. Staff. Inst. Min. and Mech. Engin., vol. x, 1890, p. 125, pl. i, fig. 2.

— — var. EXPANSA, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 261, pl. ix, figs. 2, 3.

think this is a mistake, as I only know this form from the Burnwood ironstone seam, in which bed, however, the other two species are absent.

*Specific Characters.*—Shell obliquely subquadrate, compressed, and expanded. Umbones obtuse, much nearer the anterior end than in *A. Adamsii*. The anterior end is almost obsolete and very obtuse, on which account the oblique sinus is absent. The diagonal swelling is broad, and not well differentiated from the rest of the shell. The anterior, inferior, and posterior borders form part of one general curve, which meets the inferior border posteriorly at an obtuse angle. There is no relic of a byssal notch. In other points the shell agrees with the general description of *A. Adamsii*.

*Dimensions* (Pl. XIII, fig. 9):

| | |
|---|---|
| Antero-posteriorly . . . . | 53 mm. |
| Dorso-ventrally . . . . | 42 mm. |
| Laterally . . . . . | 8 mm. |

*Localities.*—The same beds in the North Staffordshire Coal-field in which *A. Adamsii* occurs.

*Observations.*—From the description and figure in the 'Geology of Coalbrookdale' of *Unio dolabratus*, at first sight it might be considered that the variety under description was referred to, but owing to an imperfect example a partly erroneous diagnosis was given. Salter, in his observations on *A. Adamsii*, says that *A. dolabrata*, Sow., may be distinguished by having an almost obsolete anterior end, but he did not notice the fact, well shown in the drawing, that the anterior end was incomplete through fracture.

*A. Adamsii*, var. *expansa*, also differs from *A. dolabrata* in possessing a much less convex but more expanded form. Fig. 11, Pl. XII, is a form of intermediate character between *A. Adamsii* and the var. *expansa*. It possesses the general shape of the variety, but the position and shape of the umbones is very remarkable; they are more posteriorly situated than in any other specimen of *A. Adamsii* that I have met with, and are at the same time more defined, more tumid, and raised to a greater height above the hinge-line. This shell is not crushed in any way, though it was split in two in extracting it from its ironstone matrix. A large crushed specimen of the variety *expansa* which I figured in my former paper came from the shale above the Burnwood ironstone at Pitts Hill, and measured 65 mm. in length, and 55 mm. in the dorso-ventral diameter. It may be noted that at Pitts Hill, Golden Hill, and Kidsgrove the top portion of the Burnwood ironstone differs lithologically and palæontologically from the lower part. The top part consists of thin laminæ of brown and lighter coloured ironstone, passing up into a black shale, and containing *Anthracomya Adamsii* and its variety *expansa*, and a lower more compact mass without marked lines of deposition, which contains *Anthracomya pulchra* and a small Naiadites, the two forms of Anthracomya never occurring together. On the other hand, at Great Fenton I cannot make out this sharp division, and have never seen *A. pulchra* in the bed at this place.

2. Anthracomya dolabrata (*Sowerby*). Plate XIII, figs. 4—9 and 11.

Unio dolabratus, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, 1840, pl. xxxix, fig. 9.
— — *Brown*. Foss. Conch., 1849, pl. lxxxviii, fig. 17.
Anthracomya dolabrata, *Salter*. Geol. Surv. Mem. Iron Ores of S. Wales, 1861, p. 230, no fig.
— — *Hind*. Quart. Journ. Geol. Soc., p. 261, pl. viii, 1893, figs. 9, 9 *a*, 10 *a*; pl. ix, figs. 1, 1 *a*.
Non — — — Ibid., pl. ix, figs. 4 and 5.

*Specific Characters.*—Shell tumid, subquadrate, transversely elongated and expanded upwards posteriorly. The anterior end is short, compressed, and comparatively narrow, its upper border being far below the umbones. The border is sharp and bluntly rounded, passing insensibly below into the lower border, which is rapidly produced downwards and backwards, being almost straight at first, but becoming bluntly rounded into the posterior border behind. The posterior border is obliquely truncate in its upper part from above downwards, rounded below. The hinge-line is straight, much raised posteriorly, equal to about five-sixths of the length of the shell in extent. The umbones are obtuse and gibbose, raised above the hinge-line, contiguous, situated at a distance equal to about one-third of the length of the hinge-line from the anterior end. The lunule is long and narrow, the shell is obliquely swollen, the tumidity being continuous with the umbones, and gradually rounded off both in front and behind. Just anterior to the swelling is a very shallow depression, which becomes wider as it progresses towards the lower margin. Posterior to the swelling the shell is gradually and regularly compressed into the border, particularly so above, to such an extent that the posterior slope of the shell is concave. The tumidity is most developed above the widest part of the shell, being just below the level of the hinge-line; downwards and backwards the swelling gradually becomes less, but it can be traced to the inferior margin some little way anterior to the posterior inferior angle.

The *interior* has not yet been exposed.

*Exterior.*—The shell is ornamented by fine striæ and lines of growth, which, crowded in front, become slightly separated as they pass backwards over the shell, and on reaching the oblique swelling they become deflected upwards to terminate in the superior border. Periostracum thin and wrinkled.

The ligament is external and small, but erect, equal in length to about one-fourth the length of the hinge-line. Posterior to the ligament there is a shallow,

narrow, V-shaped trench between the opposing valves, the continuation of the slight groove along the border of the shell which gives attachment to the external ligament.

*Dimensions.*—The type-specimen (Pl. XIII, fig. 4) measures—

| | Antero-posteriorly. | Dorso-ventrally. | From side to side. |
|---|---|---|---|
| | 48 mm. (restored) | 29 mm. (near posterior end). | 20 mm. |
| Fig. 5, Pl. XIII, | 51 mm. | 32 mm. | 23 mm. |

*Localities.*—Pennystone beds, Coalbrookdale. Little Mine (Burnwood) Ironstone, North Staffordshire. Black Mine Middle Coal-measures, Oldham, Lancashire.

*Observations.*—This species was one of the two members of the genus first described and figured, and I am fortunately able to refigure the original specimen through the kindness of Professor Prestwich, who has lent me the fossil for examination. The anterior end is absent, a fact which was shown in the original drawing by James de Carle Sowerby (*op. supra cit.*), the lines of growth anteriorly ending abruptly, although this incompleteness was not noted in the description, where it is stated, "Anterior side small, rounded; . . . . beaks near the anterior side." Mr. Salter, judging hastily from the figure alone, says in his original description of the genus Anthracomya, "*A. dolabrata* (Sow.) is still more convex [than *A. Adamsii*], and has an almost obsolete anterior side" (*op. supra cit.*).

*Anthracomya dolabrata* is very closely allied indeed to *A. Adamsii*, and in North Staffordshire the two species are found together in the Burnwood Ironstone. On the other hand, there is a strong resemblance to certain large forms of *A. modiolaris*, so that it forms a connecting link between these species.

From *A. Adamsii*, *Anthracomya dolabrata* differs in its much greater convexity, being the most gibbose species of this genus, by the greater tumidity and height of the umbones. The greatest thickness is subumbonal, not as in *A. Adamsii* about the centre of the shell; and relatively the antero-posterior measurement is greater than in *A. Adamsii*. But forms occur intermediate in shape and character between the two,—for example, fig. 6, Pl. XIII.

I have seen nothing in Continental museums which can be considered at all like the species under description; and, indeed, the shell has been very little noticed by palæontologists. Salter dismisses it in one line, and Captain Brown simply copied Sowerby's figure, giving a very inaccurate description, and stating the locality as Coalbrookdale. It is very evident that he never saw any specimen of the shell in question.

In my paper "On the Affinities of Anthracoptera and Anthracomya" ('Quart. Journ. Geol. Soc.,' vol. xlix, p. 261) I re-described the species from the type kindly lent for that purpose by Prof. Prestwich, and I then stated that certain

specimens from Oldham and Longton were somewhat different in appearance. These shells are now re-figured on Pl. XIII, figs. 10 and 12, but from a further study I have come to the conclusion that they more closely resemble *A. modiolaris* in the stronger ridge-like oblique swelling, deeper sinus, and less produced form, and I have therefore now referred these two shells to that species. I have been able to procure only two other specimens from the original locality, Coalbrookdale, but unfortunately both of them are even less perfect than the type. There are, however, three in the Museum of the Geological Survey from the same place which have the characteristic features. These I have been allowed to examine by the courtesy of Mr. E. T. Newton. The shell figured on Pl. XIII, fig. 14, from Old Cummock, seems to be intermediate in form between the species under discussion and *A. modiolaris*, to which I have referred it on account of the nearly parallel dorsal and ventral margins. *A. dolabrata* is much more transverse, convex, and less expanded than *A. Adamsii*, with which shell it occurs in the Little Mine ironstone of North Staffordshire.

3. Anthracomya modiolaris (*Sowerby*). Plate XIII, figs. 10 and 12; Plate XIV, figs. 1—11 and 32; Plate XVI, figs. 49—53.

Unio modiolaris, *Sow.* Trans. Geol. Soc., vol. v, pt. 3, 1840, pl. xxxix, fig. 10 *bis*.
Modiola curtata, *Brown.* Foss. Conch., 1849, pl. lxxii, figs. 19, 20.
— Robertsoni, *Brown.* Ibid., pl. lxxii, figs. 24, 25.
Unio modiolaris, *Brown.* Ibid., pl. lxxxviii, figs. 5, 6.
Anthracomya modiolaris, *Salter.* Mem. Geol. Surv. of Great Britain; The Iron Ores of Great Britain, pt. 3, 1861, p. 230, pl. ii, fig. 13.
— — *Ward.* Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, 1890, pl. i, fig. 10.
— — *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 265, pl. x, figs. 24—26.
— dolabrata (pars), *Hind.* Ibid., pl. ix, figs. 4 and 5.
— sp. nov., *Hind.* Ibid., p. 271, pl. x, fig. 23.

*Specific Characters.*—Shell transversely elongated, trapezoidal, convex. Dorsal and ventral margins appear to be sub-lateral in casts, but occasionally the posterior part of the shell is produced upwards and compressed. The anterior part of the shell is small and bluntly rounded, the upper border being much below the level of the umbones. The curvature of the anterior border varies, but the anterior superior angle is always the most anterior point of the shell. The inferior border is straight for the greater part of its extent, becoming bluntly rounded at

its junction with the posterior border. The posterior border is markedly truncate from above downwards and backwards, making an obtuse angle above with the hinge-line, which is rarely rounded; the posterior inferior angle is the most posterior portion of the shell. The hinge-line is straight, extending the whole length of the upper border, directed somewhat obliquely upwards behind, so that it really never is parallel to the lower border on account of its low situation at the commencement. The umbones are obtuse, tumid, and contiguous, only slightly raised above the hinge-line, somewhat excavated in front by the lunule, which is narrow and elongated, and bevelled off posteriorly. Proceeding from the umbones downwards and backwards across the surface of the shell is a blunt oblique ridge or swelling, which gradually becomes less conspicuous as it approaches the margin of the shell near the posterior inferior angle. This oblique swelling is sometimes acute and subangular, at others equally rounded. Anterior to this gibbosity the shell is compressed, the compression becoming broader as it approaches the lower margin. Posterior to the oblique swelling the shell is expanded and rapidly compressed, especially in an upward direction, so that the posterior slope may be slightly concave.

*Interior.*—Pallial line entire; anterior adductor scar marginal, shallow. Posterior adductor scar obscurely marked, large, situated near the posterior superior angle of the shell. I only know of one example showing the hinge, and that, a left valve. The hinge consists of two portions—a short anterior part, which does not appear bevelled, which stops abruptly just anterior to the apex of the umbo, and is separated from the posterior part of the plate by a gap, possibly for the reception of a cardinal tooth in the right valve. Posteriorly, commencing just under the umbo, is a long narrow lateral tooth, formed by the lower edge of the hinge-plate, above which is a shallow elongate groove; above this is the thin raised upper edge of the hinge-plate, outside which is the elongate narrow groove, parallel to edge of the shell, characteristic of the genus.

Posterior to the lateral tooth the edge of the hinge-plate is raised and bent on itself, and bevelled to come in contact with a similar surface in the opposite valve.

*Exterior.*—The surface is marked with fine lines and striæ of growth, which have a concentric arrangement parallel to the margins of the shell, more densely crowded at the lower margin and in front; periostracum wrinkled. Shell thin.

*Dimensions:*

| | Antero-posteriorly. | Dorso-ventrally. | Laterally. |
|---|---|---|---|
| Fig. 1, Pl. XIV . . | 44 mm. | 23 mm. | 18 mm. |
| Fig. 9, Pl. XIV (Mr. Salter's type) | 31 mm. | 18 mm. | 14 mm. |
| Fig. 49, Pl. XVI (Sowerby's type) | 40 mm. | 15 mm. | 13 mm. |

*Localities.*—England: Roof of the Holly Lane at 10-foot Seams, North Staffordshire; Crawstone, Coalbrookdale; Black Mine, Oldham; Cowpen Colliery and

Whitley, Newcastle and Durham Coal-field; Grain's Ironstone, South Staffordshire; Stubb's Mine, Bardsley. South Wales Coal-field: Sychffos; Darren Pins, Aberdare. Scotland: Splint Coal, Shettleston, Ardrie, and Larkhall; Annandale, Kilmarnock, Old Cummock, Ayrshire,—all in the Upper and Middle Coal-measures.

*Observations.*—Owing to the fortunate preservation of the types of this shell and the specimen subsequently figured by Salter, I have been able to reproduce them by the kindness of Prof. Prestwich and of Sir A. Geikie, Director-General of the Geological Survey, and with the exception of two synonyms invented by Captain Brown and a mistaken reference by myself this shell has always been recognised by authors. I figure these shells from Prof. Prestwich's Coalbrookdale Collection on Plate XVI, figs. 49 and 50 representing the two specimens figured by Sowerby (*op. cit. supra*) as his fig. 10. I judge from measurements, and from the fact that Prof. Prestwich has marked both specimens as figured, that the two figures numbered 10 in the 'Geology of Coalbrookdale' are from different specimens, one showing the view from above, the other and larger one from the side. These are both more elongate than Mr. Salter's form, and have the dorsal and ventral margins more nearly parallel; but with these in Prof. Prestwich's Collection is a shell from the same locality figured on Pl. XVI, fig. 51, which is almost identical in form with Mr. Salter's shell, showing that in the young the shell had a more triangular shape. I produce on Pl. XIII, fig. 9, the shell which was the original of Mr. Salter's figure in the 'Geological Survey Memoir on the Iron Ores of South Wales.' This is also a cast, but it shows no muscle-scars, except the anterior adductor very faintly on the left side.

From the series figured from North Staffordshire it will be seen that the shape and degree of acuteness of the oblique ridge is very variable, and also the amount of expansion upwards of the posterior part of the hinge-line. This may, I think, be due to the fact that the types are all casts, and that the thin part of the valves which came absolutely into contact with each other would therefore not be indicated in casts. All the shells, it may be noted, which have this character possess more or less shell-structure preserved. Thus fig. 10, Pl. XIII, and figs. 1, 7, and 8, Pl. XIV, all show the posterior part of the hinge-line expanded upwards.

I have been fortunate enough to obtain a nearly perfect example of the hinge of this species, only the extreme anterior and posterior positions being wanting. This specimen, which is figured on Pl. XVI, fig. 52, came from the same bed at Whitley, Northumberland, where Prof. King obtained the hinge-plates on which he founded his genus Anthracosia, and shows a characteristic posterior lateral tooth, and a small cavity under the umbo, probably to receive a cardinal tooth of the opposite valve.

Whether these conditions obtain in other species is at present unknown.

Casts of *A. modiolaris* show no indication of teeth of any description, and have exactly the same characters as casts of the other species of this genus. It is, therefore, not safe to come to any conclusion as to the absence of hinge-teeth in other forms from an examination of the casts alone.

This species is easily recognised by its narrow-elongate gibbose form. It is much narrower in a dorso-ventral direction than any of the foregoing species, and can be distinguished from *A. Williamsoni* by its greater gibbosity and more pronounced oblique ridge; it generally, too, attains a greater size. These two shells do not, according to my experience, occur together. In North Staffordshire each species is limited to its own bed, *A. modiolaris* occurring in the roof of the Holly Lane Coal, an horizon some little way above the Hard Mine, where *A. Williamsoni* occurs. In Scotland the species occurs in very typical forms in the Upper Coal-measures of Lanark and Ayrshire. Mr. Etheridge, jun., stated that it was the only member of the family recognised in Scotch beds, and, indeed, it seems to be the most common. (Presidential Address, Royal Physical Soc. of Scotland, the 'Palæozoic Conchology of Scotland,' 1882, p. 50.) He says, "It is confined to the Coal-measures, and the Middle Coal and Ironstone Series." In these beds *A. modiolaris* always occurs in the form of casts. The figure of Capt. Brown's *Modiola curtata* is very similar to the specimens figured on Pl. XIII, fig. 10. There are some specimens of the same form in the Owens College Museum, locality not stated, but probably from Lancashire beds, as I know the form from the horizon of the Black Mine, Oldham. Captain Brown's specimen came from Wakefield. His figure is, I think, one of a somewhat truncate form of *A. modiolaris*, but owing to the fact that I have been unable to see many specimens I have not considered it wise to give a varietal name to these shells. Should it be shown in the future that the form exists as a well-marked local or horizontal variation, Capt. Brown's name might be given as a varietal name, *A. modiolaris*, var. *curtata*.

It is rather more doubtful whether (judging from the figure alone) *M. Robertsoni*, Brown, should be considered as a synonym of *A. modiolaris*, but the description, when correct according to the figure, agrees very well. "Elongated, inflated; beaks subcentral (which they certainly are not in the drawing), obtuse, rounded. Hinge-line short (not so in the drawing). Surface smooth, with remote shallow lines of growth." If the original was intended for a member of this genus, I know no species to which it bears more resemblance than the one under discussion, and *A. modiolaris* occurs in the Newcastle-on-Tyne Coal-field, the locality from which Captain Brown obtained his shell.

I figure on Pl. XIII, fig. 14, a large shell from the Collection of Mr. J. Smith, of Kilwinning, obtained from Old Cummock, which is probably a giant form of *A. modiolaris*. He has lent me a slightly larger one, which measures 60 mm.

antero-posteriorly, its greatest dorso-ventral measurement (towards the posterior end) is 32 mm., and 22 mm. from side to side: this specimen is more typical in shape than the one figured. I noted also in the Museum at Brussels a large example measuring 54 mm. from before backwards, from the Coal-measures of Longchamps, but have not met with the form in other Continental museums.

4. Anthracomya Williamsoni (*Brown*). Plate XIV, figs. 12—31; Plate XV, fig. 10.

? Anodonta tenera, *Eichwald*. Urwelt Russlands, p. 101, pl. iv, figs. 2, 3, and 4, 1840.
? Mytilus (Modiola) Teplofi, *de Verneuil*. Géol. de la Russie, vol. ii, p. 318, pl. xix, fig. 17, 1845.
— præpes, *de Ryckholt*. Mélanges Paléontologiques, p. 158, 1e part, pl. viii, figs. 1, 2, 1848.
Modiola Williamsoni, *Brown*. Fossil Conchology, pl. lxxi, figs. 24, 25, p. 172, 1849.
Modiolopsis tenera, *Eichwald*. Lethæa Rossica, p. 977, pl. xxxix, fig. 4, 1855–9.
— Teplofi, *Eichwald*. Ibid., p. 978, 1855–9.
Anthracomya sanguinolaris, *Salter*. Memoirs of the Geological Survey of Great Britain, "The Geology of the Country around Bolton-le-Moors," p. 35 (no description or figure), 1862.
Anodonta tenera, *Ludwig*. Pal. Urals; Palæontographica, vol. x, p. 20, pl. iii, fig. 13, 1863.
Anthracosia Weissiana, *Geinitz*. N. Jahrbuch für Mineralogie, &c., 1867, p. 682.
Pleurophorus subcostatus, *Meek and Worthen*. Geol. Surv. Illinois, vol. ii, p. 347, pl. xxvii, figs. 2, 2 *a*, 1866.
Anthracosia Bilboensis, *Kinahan*. Geol. of Ireland, pl. iv, fig. 5, 1878.
— — *Baily*. Geol. Surv. Ireland, Exp. of Sheet 137, p. 12, 1859.
— Harzi, *Achepol*. Niederrheinisch-Westfalische Steinkohlen-Gebirge, Atlas, p. 109, Supplement ii, figs. 8 and 9, 1880—1883.
Anthracomya elongata, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 266, pl. x, figs. 1—12, 1893.

*Specific Characters.*—Shell very transversely elongate, very inequilateral, wedge-shaped, and compressed. The anterior end is small, narrow from side to side and above downwards, with an acutely rounded border, which passes downward rapidly into the inferior border, and forms above a blunted right angle with the hinge-line. The posterior end is expanded and produced, and is gradually compressed into its borders, but much more rapidly so upwards into the hinge-line. The inferior border is nearly straight, but is slightly sinuated about its centre. The posterior border is truncate, with the upper and lower angles more or less rounded. The hinge-line is straight, raised, and compressed

posteriorly, rather shorter than the length of the shell. The umbones are small, contiguous, very slightly raised above the hinge-line, and situated at rather less than one third the length of the hinge-line from the anterior end. The lunule is narrow and elongated.

A broad obtuse gibbosity passes from the umbones diagonally across the shell towards the posterior inferior angle, but becomes lost on the surface before reaching that point. Anterior to the swelling is a shallow oblique sulcus, which becomes very broad at the inferior margin, and corresponding in position to the sinuosity. The superior and inferior borders are subparallel in medium-sized and small specimens. The greatest dorso-ventral measurement is at or only slightly in front of the posterior end.

*Interior.*—Normal. The anterior adductor scar is shallow and marginal, the accessory pedal scar punctiform in the usual situation. The posterior adductor scar is rarely seen, owing to its shallowness and want of definition as to its margin.

The surface of casts is marked by broad shallow sulci and fine radiating lines at the anterior end and on the posterior slope. There is an elongate groove in casts on either side of the line which marks the union of the valves posteriorly for a short distance to receive the edge of the shell, which is there expanded downwards at a right angle to itself to form the hinge-plate.

*Exterior.*—The surface is almost smooth, covered with very fine concentric lines of growth, which, crowded at their origin in front, become parallel to the inferior border as they pass across the shell till they reach the diagonal swelling, when they become reflected upwards at a rounded right angle towards the superior border. The shell is very thin and seldom preserved.

*Dimensions.*—Fig. 12, Pl. XIV, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 35 mm. |
| Dorso-ventrally . . . . | 17 mm. |
| Laterally . . . . . | 5 mm. |

*Localities.*—The roof of the Hard Mine Coal, North Staffordshire. Alldene Colliery, Gateshead. Brown's specimen is said to have come from Wakefield. High up in the Gannister series of Burrs, half a mile north of Bury, Bolton. South Wales. Mine over the Three-quarter coal, Ebbw Vale. Eastfield, Upper Coal-measures, Scotland. Ireland: Four-foot bed of shale over Coal III (Three-feet or Old Colliery coal), Bilboa and Castlecomer.

*Observations.*—I find in Captain Brown's 'Fossil Conchology' (*op. supra cit.*) a shell, which closely resembles in form those under description, under the name *Modiola Williamsoni*. He refers it to *Modiola elongata*, Williamson, MS., but gives no reason for the change of name. I unfortunately chose the latter name in preference to that of *Williamsoni* in my paper on *Anthracomya* (*op. supra cit.*), and have now to discard it in favour of the former, because the name *A. elongata*

was given by Professor Sir G. W. Dawson to a shell then named by him *Naiadites*, but now recognised as *Anthracomya* ('Q. J. G. Soc.,' vol. l, p. 437, pl. xx, figs. 7—10), but of a totally different species from that under discussion.

Judging from the description and figure of Eichwald's *Anodonta* (*Modiolopsis*) *tenera*, it is possible that it may turn out to be identical with *A. Williamsoni*, and this author's description of the form is as follows:—"Sehr dünn, aber weniger flach, sondern eher gewölbt und concentrisch gestreift, das eine Ende weit breiter, als das andere mehr zugerundete, der wirbel flach, wenig hevorstehend der schlossrande grade; beide Schalen hängen durch das Schloss von dem einen Ende bis zum andern zusammen wie dies bei Anodonten der Fall zu sein pflegt;" but it is impossible to be certain, without an examination of the shells, whether *Modiolopsis tenera* belongs to *Anthracomya Williamsoni* or *A. Wardi*, which it seems to resemble in its posterior border. I am strongly of the opinion that one of these two species will be found to belong to Eichwald's form, and in that case his name will have the priority. But there is still another uncertainty as to the name, for it is also possible that the species under description may be shown to be identical with *Mytilus* (*Modiola*) *Teplofi*, Murchison, de Keyserling, and de Verneuil, 'Paléontologie de Russie,' vol. ii, p. 318, pl. xix, fig. 17 (1845), the descriptions and figure agreeing very closely; but not having seen the shell it is difficult to speak certainly. This name is also prior to that proposed by Captain Brown; and should it be found that *A. tenera* of Eichwald is identical with *A. Wardi*, then, if *M. Teplofi* be different in any way from *A. tenera*, it may be necessary to substitute de Verneuil's name for that of Captain Brown. Eichwald, in 'Lethæa Rossica,' 1855–9, pp. 977 and 978, also gives a good description of the shells *M. Teplofi* and *M. tenera*, and in almost identical language, so that each description might well do for the other; in addition both forms are said to come from the same locality—the coal-measures of Lissitschanskaya county of the Cossacks of the Don. It may be noted here that the form and comparative dimensions of *A. Williamsoni* are very variable. *Mytilus Teplofi* is said to occur in the coal-mines of Lissitchia Balka (Donetz), below the limestone with *Spirifer mosquensis*, but whether the bed is marine or no is not stated.

Ludwig simply followed Eichwald with regard to *Anodonta tenera*, but more correctly retained his first generic reference.

I was able to examine the specimen to which Mr. Salter gave the name of *Anthracomya sanguinolaris* in his palæontological notes to the Survey Memoir on the country around Bolton. It is preserved in the Museum of the Geological Survey at Jermyn Street, and I have no doubt that this shell belongs to the species under description. Another member of the genus *Anthracomya* occurs near the same horizon, but in a different matrix. This one, however, I believe to be *A. Wardi*.

I had the opportunity, for which I thank Professor Geinitz, of examining the originals of his *Anthracosia Weissiana*, from the Saarbrücke Coal-field in the Dresden museum (*op. supra cit.*), and have no hesitation in referring that shell to the British form. Achepol's *Anthracosia Harzi*, from the Hannebal group *Bochum*, is doubtless the same shell; and, if I am correct in my surmise that the Russian form is also identical, it is interesting thus to trace the shell right across Europe.

Judging from the description of *Pleurophorus subcostatus* of Messrs. Meek and Worthen, I think it highly probable that their shell belongs to the species under discussion. I have quoted from their description *antea*, p. 87, to show that they lay stress on some of the characters which I consider typical of Anthracomya. It is said to occur in the Upper Coal-measures of Gallatin County, Illinois.

The *Anthracosia Harzi* of Achepol is, I think, a specimen of *A. Williamsoni;* curiously enough, this shell is not figured in the body of the work as a photograph, but is only in a supplement, which consists of a series of engraved figures of the shells previously described, but it is not stated if the shells are drawn from real specimens or are from restorations, and intended to give a general indication of the size and shape.

*Anthracomya Williamsoni* varies very much in the shape of the posterior end and in its comparative measurements. At times the posterior border is truncate, at others bluntly rounded, or the inferior angle may be at times somewhat prolonged, so that it may become a right angle or even slightly acute. Many specimens show a typically gaping posterior end, and as many, on the other hand, have the valves close all round. I have not been able to satisfy myself that there has been any dislocation of the valves or eversion of the shell due to pressure or injury in those specimens which gape, and am inclined to believe that in some individuals the valves gaped and in others the valves were closed. The same conditions are to be observed in the marine fossil *Sanguinolites* (*?*) *sulcata*, the *Sanguinolaria sulcata* of Phillips, from the Redesdale ironstone, some specimens of which shell appear to have widely gaping posterior ends, and others to be closed all round.

In my notes made at the Natural History Museum of Brussels I have it that the specimen labelled there *Mytilus præpes*, de Ryckholt, is the same species as *A. Williamsoni*. The original drawing does not, however, show a very close resemblance, but the description is fairly characteristic. The original specimen was from the coal shale of Mons, the one I saw was from Longchamps.

4*. Anthracomya Williamsoni, var. obtusa, *Ludwig*. Plate XV, figs. 5—9.

Unio obtusa, *Ludwig*. Palæontographica, vol. viii, p. 33, pl. iv, figs. 13—15, 1859–60.

Anthracomya obtusa, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 267, pl. x, figs. 14, 14 *a*, 1893.

*Varietal Characters.*—The shell is quadrately oblong. The anterior end is almost obsolete, constricted anterior to the umbonal fold, its border blunt and obtusely rounded. The dorsal and ventral margins are almost parallel, the inferior border straight. The posterior end is truncate, the upper and lower angles being bluntly rounded. The hinge-line is curved anteriorly as far as the umbo, but posteriorly is straight and slightly elevated. The umbones are almost anterior, not contiguous, small, hardly raised above the hinge-line. The posterior part of the shell is elongated and flattened. The upper border of the posterior umbonal ridge is prolonged backwards and downwards, but very soon becomes lost on the surface of the shell; above this line the shell is compressed into the hinge-line.

*Interior* normal.

*Exterior.*—Surface-markings as in *A. Williamsoni*.

*Dimensions:*

| | Antero-posteriorly. | Dorso-ventrally. | Laterally. |
|---|---|---|---|
| Pl. XV, fig. 5, measures . . | 25 mm. | 12 mm. | 8 mm. |

*Locality.*—With *A. Williamsoni* in the roof of the Hard Mine Coal of North Staffordshire.

*Observations.*—This form occurs sparingly with specimens of *A. Williamsoni*, and only differs from that shell in the anterior position of the umbones and obsolete anterior end, and in consequence has a less conspicuous oblique ridge, and is generally less convex, and more flattened. The shell I show (Pl. XV, fig. 5) agrees in every character with the figure and description of *Unio obtusus*, Ludwig. Seeing how the position of the umbo varies in many of the species of this genus, and that the varietal form is always found associated with *A. Williamsoni* as far as I am aware at present, I have not thought it advisable to perpetuate Ludwig's name as that of a specific form, but have adopted it as denoting a fairly constant and well-marked variety.

The varietal is much rarer than the specific form, and I should estimate that it is not met with more frequently than in the proportion of 1 in 40.

5. Anthracomya lanceolata, *Hind.* Plate XV, figs. 11, 11 *a*.

Modiola lithodomoides (on the authority of R. Etheridge, sen.), *Ward.* Trans. North Staff. Inst. Min. and Mech. Eng., vol. x, p. 130, pl. i, fig. 11, 1890.

Anthracomya lanceolata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, p. 267, pl. x, figs. 13, 13 *a*, 1893.

*Specific Characters.*—Shell very narrrow dorso-ventrally, much elongated transversely. Almond-shaped; dorsal and ventral margins parallel. The anterior end is much lower than the umbones; short and convex, its upper border straight, but directed obliquely upwards, rounded below. The inferior border is straight for the anterior fourth of its length, then slightly sinuated, after which it is produced backwards and very slightly downwards, till it curves bluntly upwards, to pass gradually into the posterior border, which is acutely pointed at its centre by a descent of the superior end and rise of the inferior border. The hinge-line is straight, extending about four-fifths of the length of the shell, not raised posteriorly. The umbones are small, only just raised above the hinge-line, not contiguous, situated at a point one-sixth the length of the shell from the anterior end. The lunule is narrow and elongated. The shell is moderately convex in its anterior two-thirds, being gradually flattened above, below, and posteriorly in the hinder third. There is a well-marked constriction, becoming broader and shallower towards the inferior margin, which it indents, in the anterior part of the shell, and an almost obsolete oblique ridge can be traced continuous with the upper border of the umbonal ridge towards the centre of the posterior end.

*Interior.*—The surface of the cast is smooth. Anterior adductor scar marginal, large; posterior scar not apparent.

*Exterior.*—Surface covered with fine lines and flattened laminæ of growth which are parallel to the inferior and posterior margin, and therefore sharply angulated or curved behind, before they pass upwards and forwards to terminate in the upper border.

*Measurements.*—The type specimen measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 32 mm. |
| Dorso-ventrally . . . . | 10 mm. |
| Laterally . . . . . | 7 mm. |

*Locality.*—Horizon uncertain. The type specimen was given me by a collier, who stated that he had picked it up at the Glebe Colliery, Fenton, where a number of seams in the Middle Coal-measures are worked.

In my original account of this species I gave the Bowling Alley Seam as the horizon of a second specimen figured now on Pl. XV, fig. 20, but which evidently should be more correctly referred to *A. Wardi*.

*Observations.*—This species is founded on a single specimen, and I have met with no shell at all like it in any of the Collections I have examined in the British Isles.

The form is distinct from all others, the one most closely approaching it being the elongate variety of *A. minima*, to which I have given the name *A. minima*, var. *carinata*, but this species is more carinate and smaller.

Mr. Robert Etheridge, F.R.S., referred my shell to *Modiola lithodomoides* (R. Etheridge, jun.), and it was on this authority that Mr. John Ward figured it under this name (*op. supra cit.*). *Modiola lithodomoides*, a species probably synonymous with *Mytilus cordiolianus*, de Ryckholt, is a much larger shell found in the typically marine beds of the Mountain Limestone, and possesses marked modioliform characters, which are conspicuously absent in *A. lanceolata*. It is impossible to confound the two shells if they are compared, as they have little or nothing in common.

6. Anthracomya Wardi, *Salter*, MSS. Plate XIII, figs. 13, 15, 16; Plate XV, figs. 1—4, 12—20.

Anthracomya Wardi, *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, p. 126, with description by R. Etheridge, F.R.S., 1890.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 271, pl. ix, figs. 9 and 10, 1893.

— angusta, *Hind*. Ibid., p. 268, pl. x, fig. 15, 1893.

*Specific Characters.*—Shell transversely oblong, with the upper and lower margins almost parallel, slightly convex.

The anterior end is short, comprising about one quarter of the shell; its border forms a right angle above with the hinge-line, but it is rounded below, and passes into the inferior border in one gradual curve. The inferior border is straight, and inclined very slightly downwards as it passes backwards. The posterior border is blunt, very slightly truncate from above downwards. The upper part is sinuated, so that the posterior superior angle of the shell is a right angle. The posterior inferior angle is blunt and rather less than a right angle. The hinge-line is straight, extending the whole length of the upper border, not elevated posteriorly.

The umbones are flattened, small, and inconspicuous, hardly raised above the hinge-line, and are situated in the anterior third of the shell. A blunt, oblique tumidity extends from the umbonal area backwards and downwards towards the

posterior inferior angle, gradually diminishing in intensity as it passes in this direction; anterior to the oblique timidity the shell is flattened. Posterior to and above the swelling the shell is compressed and flattened into the hinge-line, the flattened portion often being traversed by obscure radiating lines, especially well marked in the young state.

*Interior.*—Not known at present.

*Exterior.*—The surface is covered with lines and striæ of growth, well marked and distinct and crowded anteriorly, becoming almost obsolete posteriorly, so that the posterior portion of the shell is almost smooth. The striæ run parallel to the inferior and posterior margins, and terminate above in the hinge-line somewhat obliquely. The periostracum is wrinkled.

*Dimensions:*

| | Antero-posteriorly. | Dorso-ventrally. |
|---|---|---|
| Fig. 13, Pl. XV, measures | . 40 mm. | 16 mm. |
| Fig. 18, Pl. XV „ | . 30 mm. | 10 mm. |

*Localities.*—North Staffordshire: the shale over the Bowling Alley Coal[1] at Adderley Green, Bucknall, and Whitfield. Fulledge, Burnley. High up in the Gannister series at Burrs, half a mile north of Bury, Lancs. Roof of Shale Coal, Wakefield.

*Observations.*—This species was founded upon a comparatively poor specimen in the cabinet of Mr. John Ward, F.G.S., of Longton, by Mr. Salter, who, however, published no description; but this omission was made good by Mr. R. Etheridge, F.R.S., in Mr. Ward's book on the 'Geology of the North Staffordshire Coal-field' (*op. supra cit.*). This specimen I am able to figure on Pl. XV, fig. 14, by the kindness of Mr. John Ward. As I pointed out in my redescription of this fossil (*op. supra cit.*), Mr. Etheridge described the specimen with the preconceived idea that the shell belonged to the Anatinidæ, and that he mistook an imperfection for a central umbo, and somewhat unwisely surmised the shell to possess characteristics belonging to the genus Anatinidæ, which could not be seen in a single imperfect valve. The specimen is altogether too imperfect to serve as a specific type, but I believe that enough has been left of it to show that the shell belongs to a distinct species, of which I have been able to procure good examples. The typical posterior end of Mr. Ward's specimen is well preserved, and there can be little or no doubt that it is a similar shell to Pl. XV, fig. 13, from the Kay Shuttleworth Collection of the Manchester Museum, Owens College, which probably has attained a similar stage of growth. The other specimens from the same Collection, Pl. XV, figs. 16, 17, and 19, and the beautifully preserved

[1] Mr. Ward gives the Holly Lane seam, but I think it is more probably the Bowling Alley, the next seam above which is overlain by a shell-bed. The two seams are always worked together, and the rubbish would be on the same tip.

specimen from the Collection of Mr. George Wild, fig. 18, show what I take to be younger forms of the same species, the general shape of the shell being the same, but young forms have a sharper oblique ridge and radiating lines on the posterior slope of the shell above the oblique ridge. The typical blunt, truncate posterior end, sinuous above, is common to both the young and adult state.

M. d'Eichwald's figure of *Modiolopsis tenera* differs from *Anthracomya Wardi* in being shorter, whilst no mention is made of the oblique compression and blunt ridge, though the outline of the posterior border is very similar.

The specimen from the Holly Lane Shale at Whitfield (Pl. XV, fig. 20) possesses the characters of the young shells. The study of a series has convinced me that the shell that I described in 1893 (*op. cit. supra*) as *Anthracomya angusta* is only a very young specimen of *A. Wardi*. I refigure this specimen on Pl. XV, fig. 12; and, from a closer examination of the matrix, doubt its having come from the Hard-mine bed, several shell-bearing beds being mixed on the tip heap where I met with the specimen. I have figured on Pl. XIII, figs. 13, 15, and 16, two shells from the coal shale of Wakefield, which I take to belong to this species. The extreme posterior end has not been preserved; but if one may judge from the direction which the lines of growth take in the posterior part of the shell, it would correspond with that possessed by the type. It is possible that they may, in the future, when more specimens are obtained, be shown to be distinct. Pl. XIII, fig. 15, I have with hesitation referred to this species; it is from the roof of the 8-foot coal in the coal-measures of Durie, Fife, and was given me by Mr. Kirkby, of Leven. It has a certain resemblance to the shell from Wakefield, but it is unlike every other example in having that portion of the shell above the oblique ridge evenly gibbous. There are, however, in this place obscure radiating lines, and the posterior end, not quite perfect, was hardly so truncate as in the type; but on comparing this figure with that of fig. 19, Pl. XV, a close resemblance will be noted.

There is a fairly typical specimen of this species in the Geological Survey Collection from Burrs, near Bury, Lancs, labelled *Sanguinolites*, sp., in Mr. Salter's handwriting. It is in quite a different matrix from the specimens labelled *Anthracomya sanguinolaris* (MS.), and referred to at p. 35 of the 'Memoir of Geol. Surv.,' "The Geology of the Country round Bolton-le-Moors," which I identify as *A. Williamsoni*.

I noted a specimen in the museum at Dresden from the Grube Hannibal, near Bochum, which I believe to belong to this species. In Great Britain *Anthracomya Wardi* is rare, even in the beds in which it does occur, and has a very limited horizontal distribution.

7. Anthracomya pumila, *Salter*. Plate XVI, figs. 2, 3, and 40.

Anthracomya pumila, *Salter*. 'Iron Ores of South Wales,' p. 230, pl. ii, fig. 10, 1861.
Non — — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 269, pl. x, figs. 17, 19, 28, 29, 1893.
— carinata (pars), *Hind*. Ibid., p. 273, pl. x, figs. 16, 16*a*.

*Specific Characters.*—The shell is transversely oblong, only slightly convex. The hinge-line and ventral margins are almost straight and nearly parallel. The umbones are small with depressed non-contiguous apices, situated within the anterior third of the hinge-line; the lunule is narrow and elongate. The anterior end is short, and somewhat pointed at its anterior superior angle. The posterior end is bluntly rounded or truncate. There is an obtuse diagonal ridge which rises in the umbones, and passes backwards and downwards to the posterior inferior angle of the shell, above which the shell is compressed so as to become slightly concave and expanded upwards into the posterior hinge-line.

The *Interior* is not exposed in any of the specimens from South Wales.

*The Exterior.*—The surface is covered with striæ and lines of growth, more marked and rugose at the ventral border; periostracum wrinkled.

*Dimensions.*—Fig. 2, Pl. XVI, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 17 mm. |
| Dorso-ventrally . . . . | 8 mm. |
| From side to side . . . . | 5 mm. |

*Locality.*—Mine over Three-quarter coal, No. 6 pit, Victoria, South Wales Coal-field, and at Merthyr Tydvil.

*Observations.*—This species is at present only known from the bed above the Three-quarter coal of South Wales, which was the locality whence the original specimens described by Mr. Salter were obtained. It is just possible that the specimens I am able to figure, by the courtesy of the authorities of the Cardiff Museum, are the originals, as they have in their possession the collection of the late Mr. Adams, which Mr. Salter states contained his type.

This species differs materially from any of the forms in North Staffordshire that have come to my knowledge, being much more compressed than *A. Williamsoni* and much more elongate than *A. minima*, the latter being the typical shell in the Knowles ironstone, which Mr. Salter gave as the horizon for *A. pumila*.

In my paper on the "Affinities of *Anthracoptera* and *Anthracomya*," 'Quart. Journ. Geol. Soc.,' vol. xlix, p. 269, I doubtfully referred some young specimens of *A. Williamsoni* and *A. pulchra* to this species, but from a study of the series in the Cardiff Museum I have arrived at the conclusion that these forms are quite

distinct. *A. pumila* may be distinguished from *A. pulchra* by the flattened compressed form, and the absence of the well-marked escutcheon posteriorly.

In my paper of 1893, *op. sup. cit.*, I erroneously referred a specimen from the Strickland Collection in the Woodwardian Museum, Pl. XVI, fig. 40, to a new genus erected on two specimens which I now recognise as distinct. The one specimen agrees closely with many other forms from the South Wales Coal-field.

8. ANTHRACOMYA SUBCENTRALIS, *Salter*, 1861. Plate XVI, figs. 1 and 4—9; Plate XVII, figs. 3—5; Plate XIX, figs. 21, 21 *a*.

ANTHRACOMYA SUBCENTRALIS, *Salter*. 'The Iron Ores of South Wales,' p. 231, pl. ii, fig. 9 *a*, 1861.
MYACITES FABÆFORMIS, *Kinahan*. Geology of Ireland, pl. iv, figs. 4 *a*, 4 *b*, 1878.
ANTHRACOMYA SUBCENTRALIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 268, pl. x, figs. 30, 30 *a*, 1893.

*Specific Characters.*—The shell is transversely oblong, markedly convex. The anterior end is rounded, tumid, somewhat prominent and deep dorso-ventrally. The inferior border is almost straight, the posterior inferior angle bluntly rounded. The posterior border is bluntly rounded, and the posterior superior angle is well marked and slightly obtuse. The hinge-line is straight and almost parallel to the inferior border. The umbones are very obtuse and tumid, hardly marked off from the general gibbosity of the shell; the apices are acute, incurved, and pointing slightly forwards. They are situated about the junction of the anterior and middle thirds of the length of the shell. The lunule is well marked. The valves are evenly swollen in an oblique direction from the umbones to the posterior inferior angle, above which the shell is much compressed into the hinge-line, so that it is often slightly concave. The ligament is external, very short, and not much elevated, and there is a long narrow groove on each side of it representing the escutcheon.

The *Interior* is unknown.

*The Exterior.*—The surface is almost smooth, but is marked towards the ventral border by well-defined lines of growth. The periostracum is wrinkled.

*Dimensions.*—Fig. 21, Pl. XIX, in the Museum of the Geological Survey, Jermyn Street, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 25 mm. |
| Dorso-ventrally . . . . | 13 mm. |
| From side to side . . . . | 10 mm. |

*Localities.*—South Wales: mine over the Three-quarters Coal, No. 6 Pit, Victoria. The roof of the Hard-mine Coal, Mossfield Colliery, Longton. The

Cockshead Ironstone, Hulme Colliery, Longton. *Ireland.*—The roof of the Three-foot Coal, Bilboa, Queen's County.

*Observations.*—This species appears to be a rare form even in South Wales. It is quite distinct from *A. pumila*, from which its convex form at once distinguishes it. The position of the umbones even in Mr. Salter's original figure hardly merits the epithet subcentral. I have, however, shown that the position of the umbones on the hinge-line is a varying factor in other species of this genus, and therefore do not regard such a character as of any value in specific determination. I figure, by the kind permission of the Director-General, three specimens, Pl. XVII, figs. 3, 4, 5, from the Three-foot Coal of Bilboa, Queen's County, Ireland, which had been named *Myacites fabæformis* (Kinahan). These shells have all the characters of Salter's *A. subcentralis*, to which I have now referred them. The hollow character of the compressed upper and posterior portion of the shell is well shown in all the examples. The blunt truncate posterior end is very characteristic. The specimens, Pl. XVI, figs. 5—8, from the Cockshead Ironstone are much crushed and distorted, figs. 7 and 8 having lost the anterior end by these means, but the hollow posterior slope and peculiarly truncate posterior are well marked.

The best specimens of this species that I know are in the Collection of the Geological Survey, one from South Wales, the other from Bilboa, Queen's County, Pl. XVII, fig. 3. It is curious that the palæontologists in Ireland never seem to have adopted Mr. Salter's genus for their shells, for, as far as I can trace, the genus *Anthracomya* has never been credited to the Irish Coal-measures until now.

In the 'Geological Survey Memoir,' "The Iron Ores of Great Britain," part 4, p. 294, Mr. Salter mentions the occurrence of *A. subcentralis* with *A. pumila* in the Knowles shale of the North Staffordshire Coal-field, but I know of no specimen from these beds which can be in any way referred to this species. As far as is at present known, the forms *A. Phillipsii* and *A. minuta* are the only species of this genus which occur at this horizon. I am unable to trace the original specimens on which these lists were founded, either in Messrs. Ward and Garner's collections or in the collection of the Geological Survey, so that it is impossible to discover on what grounds the references were made.

9. Anthracomya obovata, *Hind.* Plate XVI, fig. 41.

Anthracomya obovata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 270, pl. x, figs. 22, 22 *a*.

*Specific Characters.*—Shell obovate, inequivalve, the left valve being more convex. Anterior end almost obsolete, tumid, bluntly pointed. Posterior end

expanded, flattened backward and downward, and into the hinge-line, which is much raised. The hinge-line is straight, about three-quarters the length of the shell. Umbones prominent, blunt, separate, situated one-seventh the distance of the hinge-line from the anterior end. The inferior border is curved rapidly downward from the anterior end, then becomes bluntly and gently rounded into the posterior border, which extends in the form of a regular semicircular curve from the inferior to the superior angle. A blunt swelling, rapidly flattened on its posterior side, extends from the umbo to a point in the inferior border anterior to its posterior limit. There is no appreciable byssal sulcus, but there appears to have been a byssal notch at the junction of the anterior and middle thirds of the inferior border.

*Interior* smooth, with folds of growth; anterior and posterior adductor scars as in other species. Ligament external. Lunule distinct.

*Measurement.*—Antero-posterior measurement 30 mm.; greatest dorso-ventral (at posterior end) 17 mm.; from side to side 7 mm.

*Locality.*—Roof of the Hard-mine Coal, Adderley Green, Longton.

*Observations.*—I have found only one specimen of this very distinct and characteristic form. It looks much like some forms of *Anthracoptera*, from which it can be distinguished by its umbones and hinge-line. It has occurred to me that this may well be an example of mimicry, the more so because the form *Naiadites elongata* resembles very closely certain forms of *Anthracomya*; in fact, it is only on very close examination of the umbones and hinge-lines that these forms can be correctly referred to their proper genera.

The fact that I have only been able to obtain one good example of this species throws some doubt as to its reality, and it is quite possible that the shell may be a deformity or even a hybrid. The expanded posterior end and anterior position of the umbones indicate an approach towards the form of *A. senex*, but there is no pronounced angularity of the diagonal ridge.

10. ANTHRACOMYA SENEX, *Salter*. Plate XV, figs. 21—28.

ANTHRACOMYA SENEX, *Salter*. "Iron Ores of South Wales," Mem. of the Geol. Surv., 1861, p. 230, pl. ii, fig. 10.

— — *Hind*. Quart. Journ. Geol. Soc., 1893, pl. x, p. 270, figs. 20, 20 *a*, 21.

*Specific Characters.*—Shell transversely cuneiform, oblique, moderately convex. The anterior end is small, ellipsoidal, and blunt, and the narrowest part of the shell. Its border is regularly curved, and passes gradually into the inferior border, which is directed downwards and backwards, being slightly sinuated about its centre. The posterior border is obliquely truncate from above downwards and

backwards, making an obtuse angle above with the extremity of the hinge-line, and below it forms a blunted acute angle with the inferior border, the posterior inferior angle being extended far behind the rest of the shell. The hinge-line is straight, elevated posteriorly, inclined to the inferior border, so that if each were produced forwards they would meet at a very acute angle. It is much shorter than the greatest antero-posterior diameter of the shell. The umbones are obtuse, swollen, slightly raised above the hinge-line, and not contiguous, and are situated anteriorly; they are not conspicuously marked off from the rest of the shell in front, but posteriorly have the upper border continuous with a well-marked oblique, more or less angulated ridge, which passes downwards and backwards to a point somewhat anterior to the posterior inferior angle, becoming gradually less marked as it traverses the shell. Anterior to the oblique ridge is a well-marked oblique sulcus, which becomes shallower but broader as it approaches the inferior margin, which is sinuated at this point. This sulcus can be traced nearly up to the umbones themselves. Posterior to and above the oblique ridge the shell is rapidly constricted, so as to become concave on the posterior slope, above which the valves are compressed and expanded upwards.

*Interior.*—Specimens showing the muscle-scars and hinge-line have not yet been obtained.

*Exterior.*—The surface of the shell is covered with very fine lines of growth, and in the absence of periostracum appears almost smooth.

The periostracum is thick and very much wrinkled, especially posteriorly, but with no definite pattern. The external ligament is almost as long as the posterior hinge-margin and comparatively large.

*Dimensions.*—The type specimen, Pl. XV, fig. 21, measures—

| Antero-posteriorly. | Greatest dorso-ventrally. | Laterally. |
|---|---|---|
| 25 mm. | 14 mm. | 15 mm. (but valves are somewhat open). |
| Pl. XV, fig. 26, 29 mm. | 15 mm. | 12 mm. |

*Localities.*—Darranpins, Ebbw Vale. Sychffos: Cwm Aman, South Wales. Roof of the Hard-mine Coal, and the Cockshead Ironstone, Adderley Green, North Staffordshire.

*Observations.*—By the kind permission of Sir Archibald Geikie, Director-General of the Geological Survey, I have been able to study and figure the specimen on which Mr. Salter founded this species which is placed in the Collection of the Geological Survey at Jermyn Street, Pl. XV, fig. 21. The shell has the valves partially open, and the inferior and posterior borders are incomplete at the extreme edge. It is a gibbose shell with very strongly marked oblique keel, and the periostracum much wrinkled, but not in quite such a regular fashion as depicted in Mr. Salter's figure. If the right valve be examined it is found that

the V-shaped arrangement of the wrinkles is at right angles to that which obtains in the left valve, and that the condition is purely accidental. Mr. Salter says of this shell (*loc. supra cit.*), "The general appearance is that of an ordinary convex *Modiola;* but the epidermis, deeply wrinkled V-fashion over the posterior slope, shows its true affinity." He goes on to say, relying on this *quasi*-affinity to Myadæ which he allowed to overbalance the evidence afforded by shape, "We cannot get at the interior, but there is not much doubt that there is a pallial sinus, and there were probably long siphonal tubes covered by a thick epidermis, the animal burrowing in the mud as most of the Myadæ do"—a condition which subsequent investigation has shown to be absent. It was only under the head of *A. senex* that any observations are made with regard to the generic affinity of Anthracomya, and it is probable that the wrinkled periostracum of *A. senex* was the chief factor in referring this genus to the Myadæ. I have on this account gone into the details given by Mr. Salter, and have quoted fully from his remarks. *A. senex* is a rare shell, and I have only met with one other specimen from South Wales, also in the collection of the Geological Survey, but have obtained a few from the Hard-mine and Cockshead Ironstone of North Staffordshire, but in these beds it appears to be very rare. This species is easily distinguished from all others by its oblique wedge-shaped gibbose form, and by the raised hinge-line posteriorly and strongly marked diagonal keel.

11. Anthracomya Valenciensis, *R. Etheridge, jun.*, nov. sp. Plate XVI, figs. 44—48.

*Specific Characters.*—Shell small, pisiform, tumid. The anterior end is small, regularly swollen, and has a convex border. The posterior end is expanded and compressed with a bluntly convex border. The inferior border is almost straight, passing with a gradual curve in front and behind into the anterior and posterior borders. The hinge-line is straight, elevated posteriorly, somewhat shorter than the greatest antero-posterior measurement of the shell. The umbones are small and inconspicuous, slightly raised above the hinge-line, and non-contiguous. The shell is evenly swollen in an oblique direction, the swelling being soon lost on the surface of the shell.

*Interior.*—Not known.

*Exterior.*—The surface is covered with fine lines and striæ of growth which run parallel to the anterior inferior and posterior borders. The periostracum is wrinkled.

*Dimensions.*—Fig. 46, Pl. XVI, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 8 mm. |
| Dorso-ventrally (behind) . . . | 5 mm. |
| From side to side . . . . | 4 mm. |

*Locality.*—Dalmeny railway-cutting, near Wester, Dalmeny. Lower Carboniferous of Scotland.

*Observations.*—This little species has the characteristic shape of the genus. A set of fourteen specimens are in the Geological Survey Collection of Edinburgh, labelled *A. Valenciensis*, MS., R. Etheridge, jun., all from the locality stated above. This species appears to be the smallest and, at the same time, the earliest member of the genus known in Carboniferous times. I know of no other species which can be mistaken for it, as it is much more regularly globular than *A. minima*, unless it turns out to be the perfect form of *A. lævis*, var. *Scotica*, which is only known in a much-compressed condition.

12. Anthracomya pulchra, sp. nov., *Hind.* Plate XV, figs. 29—49.

Anthracomya pumila, pars, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 269, pl. x, figs. 28 and 29.

*Specific Characters.*—Shell transversely oblong, convex, at times almost cylindrical. The anterior end is compressed, and has its border almost circularly curved, the posterior superior angle not being prominent. The upper border of the anterior end is much below the level of the umbones. The inferior border is straight or slightly concave, joining the anterior border by an abrupt curve, while posteriorly it forms a more or less obtuse angle with the obliquely truncate posterior border, so that the posterior inferior angle is well marked and somewhat acute, and this point is the most posterior portion of the shell. The hinge-line is straight, deviating very slightly from parallelism with the ventral edge. The umbones are obtuse, gibbose, almost contiguous, and raised above the hinge-line. They are situated anteriorly at a point distant from the anterior end equal to about one-fifth the length of the hinge-line. The umbones are excavated in front by a well-marked lunule, and posteriorly there is a well-marked escutcheon or groove on each side of the external ligament, which is erect, and small and short. The posterior or greater portion of the shell is convexly swollen in an oblique direction from the umbo to the posterior inferior angle. The compression anterior to the ridge, characteristic of this genus, is only seen at the lower edge of the shell, about the centre, as an almost obsolete broad sulcus. Above the swelling the shell is

rapidly compressed into the hinge-line, so that this portion of the shell is slightly concave, and at times is crossed by obsolete radiating lines.

*Interior.*—Normal; hinge like that of *A. modiolaris*, the details being very minute.

*Exterior.*—The surface is almost smooth, but there are very fine striæ and lines of growth. Periostracum wrinkled.

*Dimensions.*—A full-grown example from the Burnwood Ironstone, Golden Hill, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 23 mm. |
| Dorso-ventrally . . . . | 11 mm. |
| From side to side . . . . | 9 mm. |

*Localities.*—The Burnwood or Little-Mine Ironstone of North Staffordshire, Fenton, Golden Hill, Pitts Hill, and New Chapel.

*Observations.*—At Golden Hill (North-Staffordshire Coal-field), the Burnwood or Little-Mine Ironstone, as it is called in the Longton district of the same coal-field, consists of a finely laminated ironstone above, containing *A. Adamsii ;* but its lower part is much more homogeneous and not at all well stratified, and in this part of the bed *A. pulchra* is found with *Naiadites carinata.* At Fenton, however, the species does not seem to occur, though *A. Adamsii* is very common, and is nearly always found in a perfect state. I believe that this is the shell which Mr. Salter identified as *A. pumila* in his remarks on the palæontology of the North Staffordshire Coal-field (*op. supra cit.*), but on comparing it with the South Wales specimens the difference is very apparent; *A. pulchra* is much more convex. The oblique ridge is less angular than in *A. pumila*, Salter, or in *A. Williamsoni*, Brown, and the posterior end not expanded to so great an extent as in the Welsh shells. I figured two crushed specimens of this shell as *A. pumila* (*op. supra cit.*), the characteristic features being obliterated. I have never met with this species from any other seam or coal-field. It is very abundant and in a splendid state of preservation in all stages of growth in the bed stated.

I have figured a series, Pl. XV, figs. 29—49, to show the change of shape resulting from growth. The absence of any marked expansion of the posterior end in the young is very apparent, room for the viscera being obtained by a much greater convexity of the shell posteriorly than obtains in most of the species of the genus, but later on in life the typical shape is always present. I have not figured any specimen showing the hinge. The details are very small, and it is difficult to get specimens altogether free from matrix; but from fragments I have seen I believe the hinge-apparatus to be identical with that of *A. modiolaris.* No casts have as yet been obtained.

13. Anthracomya minima, *Ludwig*. Plate XVI, figs. 21, 22, 24—34.

? Modiola minuta, *Brown*. Fossil Conch., 1849, pl. lxxii, fig. 29.
Non — minima, *Brown*. Ibid., pl. lxxii, fig. 28.
Anodonta minima, *Ludwig*. Palæontographica, Bd. viii, 1859–60, p. 36, pl. v, fig. 14.
Modiola Carlotta, *Römer*. Geol. und Palæontol. von Oberschlesien, 1870, p. 76, foot-note.
— sp., *Volpersdorf*. Zeitschrift der Deutsch. Geol., vol. xvii, 1865, p. 276, Taf. vi, fig. 6.
— (or Anthracomya), undescribed form, *Salter*. 'Iron Ores of South Wales,' Geol. Surv. Mem., 1861, p. 233, pl. ii, figs. 1, 2.
Anthracomya minima, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 272, pl. ix, figs. 11, 12.

*Specific Characters.*—Shell small, ovately and obliquely triangular. The anterior end is very short and tumid, with a rounded border. The posterior part forms the greater portion of the shell; it is expanded and compressed, especially upwards. The posterior border is rapidly and obliquely sloped from above downwards and backwards in its upper portion, but at the lower angle is truncate and bluntly rounded, this angle being the most produced part of the shell. The inferior border is almost straight, but has a slight sinuosity. The hinge-line is straight, equal to half the extreme antero-posterior diameter of the shell in length, and if the upper and lower borders were produced forwards they would meet at an acute angle.

The umbones are small, swollen, not contiguous, situated very far forwards. From the umbones there passes downwards and backwards an oblique swelling, which extends almost to the posterior inferior angle; anterior to this swelling is a well-marked sulcus, which becomes broader and shallower as it approaches the inferior margin.

*Interior.*—As far as can be seen in fragments the arrangement of muscular impressions is normal.

The external surface is almost smooth, marked with many very fine concentric lines and folds of growth, which are crowded together in front, but become separated as they pass backwards, following the general shape of the shell, and when they reach the oblique swelling are gradually curved upwards, so that they pass in a forward direction to the superior border.

*Dimensions.*—Pl. XVI, fig. 27, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 8 mm. |
| Dorso-ventrally . . . . | 4 mm. |
| From side to side . . . . | 2 mm. |

*Distribution.*—Knowles Ironstone, Longton railway-cutting, south of Kidsgrove, in North Staffordshire. Middle Coal-measures. Prestolee, near Manchester. Black Band, Blaina, South Wales. Wylam Colliery, Northumberland. Scotland: Possil; Langton Burn, Dunse; Blackadder Water, Dunse.

*Observations.*—When I gave the name *A. minima* to this shell in 1893 I was unaware that the species had been named or described before. By a lucky coincidence I was fortunate enough to hit on the same specific name as that given by the earliest observer, R. Ludwig. It was the examination of his type specimens at Dresden which convinced me of the identity of his shells, though they were crushed, with the British forms. Unfortunately, too, his figures are not good. At that time Professor Geinitz showed me some specimens labelled *Modiola Carlotta*, Römer, which I could not distinguish from *Anthracomya minima*. I have therefore placed Römer's name as a synonym. Römer thought his shell had been previously described by Volpersdorf, who however, only gave it the generic name of Modiola.

Salter figures some small shells from the South Wales Coal-field, of whose generic affinity he evidently did not feel quite sure, as he calls them Modiola or Anthracomya. Judging from figures only, I think it probable that two of his specimens (figs. 1 and 2, not 3) may be referred to *A. minima*.

The general form of *A. minima* closely resembles that of *A. Phillipsii*, but it is much smaller; and owing to the fact that the latter shell nearly always occurs crushed, it is next to impossible to make out accurately many of its characters. The two forms were very gregarious in habit, and are found in large numbers in certain beds, but as far as I know not together; other species and genera are conspicuously absent, with the possible exception to be noted below. Still there is nothing antagonistic to the view that one was only a dwarfed form of the other.

There often occurs both in Staffordshire and Lancashire, in a bed with *A. minima*, a form to which I gave the name *Anthracomya carinata*, and it would appear on comparing it with a typical specimen of the former to be quite distinct; but a series of intermediate forms occur which completely connect the two. I have, therefore, now placed *A. carinata* as a variety of *A. minima*. There is a resemblance also between our shell and the forms called on the Continent *Unio carbonarius*, Bronn, and *Unio Goldfussianus*, de Koninck. It is very difficult to form any conclusions as to what shells are represented by these names, owing to the disappearance of all the types, and the inaccuracy of authors, to which Professor Geinitz drew attention in a paper in 'Neues Jahrbuch' for 1864, p. 651. In the 'Petrefacta Germanica,' p. 181, pl. cxxxi, fig. 20, Goldfuss gives a figure of *Unio uniformis*, Sowerby, which, as de Koninck pointed out in his remarks on *Cardinia ovalis* in his 'Animaux fossiles du bassin Carbonifère de la Belge,' p. 74, is totally distinct from Sowerby's shell, and he

proposed the name *Goldfussiana* in its place; Sowerby's original *Unio uniformis* being an Oolite shell from Felmersham, Bedfordshire, and Goldfuss's *Unio uniformis* being totally different in shape, size, and occurring in the Carboniferous beds of the neighbourhood of Kusel. *Unio carbonarius*, the *Mytulites carbonarius* of Boué, figured by Bronn and Römer in 'Lethæa Geognostica,' Theil ii, p. 416, certainly belongs to the genus Anthracomya, and I believe will be found to be the same species as that figured by Goldfuss as *Unio uniformis*.

The figures of *Unio carbonarius*, Goldfuss, and *Cardinia carbonaria*, de Koninck, differ much from that of *U. carbonarius*, Bronn and Römer, to whose type, however, they both refer their specimens. All three authors also refer their specimens to *Tellinites carbonarius*, Schlotheim; but this specimen is said to come from Häring in the Tyrol, a locality where, although coal is present, the beds are, I am told by Professor Geinitz, of Tertiary age. Neither Goldfuss nor de Koninck says anything about their shell having an expanded end or oblique swelling (both present in Bronn's form), so that it must be concluded that the *Unio carbonarius*, Goldfuss, and *Cardinia carbonaria*, de Koninck, differ from *Unio carbonarius*, Bronn, and that the specific name *carbonarius*, having been applied by Schlotheim to a Tertiary shell, must be dropped. *Unio uniformis*, Goldfuss, and *Cardinia Goldfussiana*, de Koninck, are probably of the same species as Bronn and Römer's *U. carbonarius*. *Anthracomya minima* is much more oblique and less transverse than *Anthracomya Goldfussiana*, and has the oblique ridge and sulcus more developed, and the posterior end more expanded. It may be noted that the German shell is very thin, and unless well cleared from the matrix the thin expanded upper part of the posterior end may not be exposed, and the specimen will have the external appearance of a Carbonicola, for which, I have noted, it has been often mistaken. The lines of growth, though, are distinctly characteristic of Anthracomya rather than of Carbonicola.

It is difficult to obtain specimens of *A. minima* free from the matrix, but by calcination Mr. C. Roeder has managed to procure some fairly perfect examples, though of course much shrunken in size. The ironstone contains also fragments of Lepidodendron and other vegetable remains.

Larger specimens of a shell, Pl. XVI, figs. 21 and 22, are in the collection of the Geological Survey of Scotland, from near Dunse, which only differ from the English examples in size, and which I have therefore referred to this species.

13*. ANTHRACOMYA MINIMA, var. CARINATA. Plate XVI, figs. 35—39.

Non ANTHRACOMYA CARINATA (pars), *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 273, pl. x, figs. 16, 16 *a*.

*General Characters.*—Very much produced transversely, anterior end very small and almost obsolete, bluntly rounded, sloping rapidly into the inferior border, which is so slightly convex as to appear almost straight. The posterior part is produced, forming about seven-eighths of the shell, with a strong oblique ridge passing downwards and backwards to the inferior border at the junction of the third and posterior fourth of its extent, when it becomes lost on the surface of the shell. Anterior to the ridge the shell is sinuated and flattened, and very rapidly compressed into the lower border. Above the ridge the shell is also rapidly compressed into the superior border. The posterior border is curved elliptically.

The hinge-line is straight, equalling about three-fourths of the length of the shell in measurement. The umbones are situated very anteriorly, tumid, and small.

The exterior is covered with fine striæ and lines of growth, which, starting from the anterior end, become curved upwards as they reach the oblique swelling, and are reflected up to the superior border. Periostracum thick and wrinkled.

*Interior* not seen.

*Dimensions.*—Fig. 39, Pl. XVI, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 22 mm. |
| Dorso-ventrally (at posterior end) . . | 8 mm. |
| Laterally . . . . . | 7 mm. |

*Localities.*—From an ironstone band on the Middle Coal-measures of Lancashire at Prestolee. The Knowles Ironstone bands, North Staffordshire Coal-field.

*Remarks.*—The specimen I first described I now find to have greater affinity with *A. pumila*, Salter; and, moreover, it comes from the locality of Salter's type. I had neither seen the series of shells from the South Wales Coal-field in the Cardiff Museum, nor the intermediate forms which connect *A. carinata* with *A. minima*. I have now found them in the beds both in Lancashire and North Staffordshire which contain this shell, but owing to the differences in form and size, and the comparative rarity of this variety, I have still retained the name *carinata*, but as a varietal form of *A. minima*. The chief difference which marks off this variety is in the very rapid and excessive growth of the posterior end, and the consequent throwing into greater relief the oblique ridge, which, instead of being directed towards the inferior posterior angle, is left behind some distance along the lower border.

I noted in my first description that this shell somewhat resembled *Anthracomya lanceolata*, Pl. XV, fig. 11. It may be that this form stands in the same relation to *A. Williamsoni* that the variety *A. carinata* does to *A. minima;* and I am the more inclined to think that this is the case, as I meet with an elongate form of *Anthracomya pulchra*, Pl. XV, fig. 29, and an elongate form of *Anthracomya Adamsii*, Pl. XII, fig. 9, each occurring and only occurring in the same beds as the normal variety, though this may not be true of *A. Williamsoni* and the form *A. lanceolata*, as the actual horizon at which the latter occurs is at present uncertain.

14. Anthracomya Phillipsii. Plate XVI, figs. 10—16.

Unio Phillipsii, *Williamson.* Phil. Mag., vol. ix, p. 351, 1836.
Non — linguiformis, *Phillips.* Murchison's Sil. Syst., p. 88, 1839.
Modiola, sp., *Binney.* Mem. Lit. Phil. Soc. Manchester, 2nd ser., vol. xii, p. 221, note, 1855.
Anthracomya Phillipsii, *Huxley and Etheridge.* Cat. Foss. Mus. Pract. Geol., pp. 157—160, 1865.
— — *T. Rupert Jones.* Geol. Mag., vol. vii, p. 217, pl. ix, figs. 3 and 18, 1870.
— — *R. Etheridge, jun.* Ibid., ser. 2, vol. iv, pp. 243, 244, pl. xii, figs. 6 and 7, 1877.
— — *Hind.* Quart. Journ. Geol. Soc., vol. xlix, 1893, p. 262, pl. ix, figs. 6, 6*a*, 7, 8; pl. x, fig. 27.

*Specific Characters.*—Shell transversely obliquely oval, modioliform, elongated in a diagonal direction. The anterior end is small, its margin rounded. The posterior end is compressed, expanded downwards and backwards, while above it is rapidly compressed into the upper border, which is elevated posteriorly. The hinge-line is straight, about one-half the length of the diagonal of the shell. The ventral margin is convex, passing with a gentle curve into the anterior end, and becoming straight shortly before it reaches the posterior end. The umbones are anterior and directed forwards, very blunt and gibbose, the beaks themselves inconspicuous. The shell itself is fairly tumid, and the valves are gibbose. There is no sign of an oblique constriction anterior to the gibbosity, which is itself very gradual in its form. Behind the gibbosity the valves are so rapidly compressed as to become hollow on the posterior slope.

*Interior.*—As far as can be seen in Pl. XVI, fig. 14, which is a cast, the interior is normal, but the anterior adductor scars are not seen, owing to damage to the specimen.

*Exterior.*—The surface is covered by fine and coarse striæ and lines of growth, which have the general arrangement which obtains in this genus. Periostracum thick and wrinkled.

*Dimensions.*—The type specimen, Pl. XVI, fig. 10, measures—

| | | |
|---|---|---|
| | Greatest diagonal . . . | 20 mm. |
| | Greatest dorso-ventral . . . | 12 mm. |
| Pl. XVI, fig. 14— | Greatest diagonal . . . | 20 mm. |
| | Greatest dorso-ventral . . . | 11 mm. |
| | Lateral . . . . | 8 mm. |

*Localities.*—Blackband ironstone and shales of the North Staffordshire Coal-field, as far down as the Basseymine and the Gubbin ironstone. The Knowles ironstone series, North Staffordshire. The Upper Coal-measures of Ardwick, Lancashire; Slade Lane and Bradford, near Manchester. Blackband, Blaina, South Wales. Coal-pit, Heath, and black shale, Kingswood deep pit; Bristol Coal-field; Speedwell pit, Gloucester; Trafalgar pit, Cinderford, Forest of Dean.

*Observations.*—The original type of this species was named by Dr. W. C. Williamson, who obtained his specimen from the Spirorbis-limestone shale of Pendlebury. He described it as "delicate, broad, and wide proportionally to its length," and says his specimen resembled that vague shell *U. nuciformis*, of Hibbert, of which all trace has been lost. He states, too, that in this bed the shell is always compressed. I am able to figure this shell in Pl. XVI, fig. 10, by the kind permission of the authorities of the Manchester Museum, Owens College. Phillips, in a letter quoted by Murchison in his 'Silurian System,' p. 88, describes four different shells (Unios) as occurring in these beds. *One* — smooth, tumid, with prominent beaks, but with very distinct lines of growth, and rather short, straight hinge-lines, looks like a young *Modiola; a second form*, with nearly elliptical hinge-line, deviating considerably from parallelism with the front ends in a prominent angle; "lines of growth strong, shell very thin, beaks slightly prominent. Mr. Williamson has inaccurately referred this shell to *Unio nuciformis*. It occurs in the red beds above the limestones, in the black bass and in the underlying Coal-measures."

A "third species, which I named *Unio rugulosus*, is of obliquely expanded or semi-elliptical form, the hinge-line forming the diameter [I suppose he means when both valves are lying open, flattened out, connected by the hinge]. Surface concentrically marked with broken undulations, often showing radiations on the posterior slopes; shell exceedingly thin. Unionidæ of the same species occur in the bed of mottled marls above the [Spirorbis] limestones, in the black bass or shale above the main limestone, and in the shale beneath all the calcareous bands."

A difficulty at once arises as to which shell Phillips considered identical with Williamson's *Unio Phillipsii*. Four forms altogether are described in the letter to Sir Roderick Murchison quoted above; the first "a shell so very like a young *Modiola*," and three forms referred to *Unio*. In the remark on the first of these

Unios, which was not mentioned by name, Phillips says, "Williamson has inaccurately referred this shell to *Unio nuciformis*" [of Hibbert]. The second Unio is named *Unio linguiformis* = *Unio Phillipsii*, Williamson, although no grounds are given for this apparently arbitrary change of name, in spite of a description, though meagre, having been published, part of which I have quoted above. It is to be noted that Mr. R. Etheridge, in his redescription of this species (*op. supra cit.*), adds "without description" to his reference to Williamson's original publication: quoting him, I fell into the same error in my former paper.

Williamson only describes one shell, but mentions later in his paper remains which had been mistaken for fish scales, measuring about a quarter of an inch across. But it is the shell which he refers to *Unio nuciformis* and calls *Unio Phillipsii*. Moreover this species cannot be said to have a "hinge-line (which) deviates very little from parallelism to the front lines of growth." Indeed, Phillips's first Unio shell appears from the description to correspond better with Williamson's form. Neither Professor Rupert Jones nor Mr. R. Etheridge, jun., noticed this curious mistake of Professor Phillips, both authors giving *Unio linguiformis* as a synonym of *Anthracomya Phillipsii*.

The original specimen being that of a shell crushed flat, it is difficult to judge what exactly would be the form of uncrushed examples. I have referred fairly perfect shells from the horizon of the Knowles ironstone to this species, Pl. XVI, figs. 11—13, one of which (fig. 11) is a cast, and the exact outline of the shell cannot be seen on account of imperfections of the extreme anterior portion and the posterior border. The others (figs. 12 and 13) would, I think, if crushed flat, exhibit a similar form to those of *A. Phillipsii*, which occur in such numbers in the higher beds.

If I am correct in my reference, *A. Phillipsii* was a fairly tumid shell, so gently tumid that the diagonal ridge so characteristic of the genus is not apparent; and this view is supported by an observation by Mr. E. W. Binney, that in the uncrushed state the shell closely resembles a Modiola. This is so, speaking broadly, but the position and shape of the umbones are characteristically different from that which obtains in Modiola. I have recently obtained both crushed and uncrushed specimens of this species from the Speedwell pit, Gloucestershire. In these shells the oblique ridge is more acute, and not so gradually gibbose as in the forms from the Knowles Ironstone, Fenton.

The shell seems to occur at several horizons in the Bristol district, judging from the matrix in which they occur, but I am unable to give the exact beds. This is, I believe, a new discovery (the shells were collected by Mr. Stock, of Bristol), and an interesting one, as molluscan remains are very rare indeed in this coal-field.

In crushed examples it is often very hard to distinguish between *Anthracomya*

and *Naiadites* (*Anthracoptera*); and, indeed, in perfect examples there is a striking resemblance. I rely principally on the position and shape of the umbones, which are almost terminal and pointed forwards in *Naiadites*.

This shell occurs in very large numbers closely packed and all crushed flat in the black bands and ironstones of the Upper Coal-measures of North Staffordshire, and here to the exclusion of all other molluscs.

Professor T. Rupert Jones, F.R.S., who appears to have been the first to figure this shell ("On some Bivalve Entomostraca from the Coal-measures of South Wales," *loc. supra cit.*), draws attention to the resemblance in shape between some of the Carboniferous Estheriæ and the genus Anthracomya.

15. ANTHRACOMYA LÆVIS, var. SCOTICA, *Dawson*. Plate XVI, figs. 17—20, 42, 43.

? UNIO RUGULOSUS, *Phillips*. Murchison's Sil. Syst., p. 88, 1839.
? CARDINIA FREYSTENII,[1] *Geinitz*. Die Versteinerungen de Steinkohlenformation in Sachsen, pl. xxxv, fig. 7 *a*, a, 1855.
NAIADITES LÆVIS, *Dawson*. Acadian Geol., 1st edit., 1860; 2nd edit., p. 204, fig. 44, 1868.
ANTHRACOMYA (NAIADITES) LÆVIS, *Salter*. Quart. Journ. Geol. Soc., vol. xix, p. 79, fig. 2, 1863.
? ANODONTA OBSTIPA, *Ludwig*. Palæontographica, Bd. x, p. 22, pl. iii, figs. 2, 2 *a—f*, 1863.
ANTHRACOMYA SCOTICA, *R. Etheridge, jun.* Geol. Mag., dec. 2, vol. iv, p. 244, pl. xii, fig. 8, 1877.
— LÆVIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 264, pl. x, fig. 31, 1893.
— — — Ibid., vol. l, p. 441, pl. xx, fig. 12, 1894.

*Specific Characters.*—Shell obliquely broad-ovate. Dorso-ventral and antero-posterior diameters almost equal, hitherto only known as flat and compressed. The anterior end is short and pointed, its border is rapidly produced downwards and forwards in a curve to join the lower border, which is with the lower part of the posterior border almost circular. The posterior end is flattened and produced ventrally. The border is rounded below, but almost straight above, and obliquely truncate from above downwards. The hinge-line is straight, not quite as long as the transverse diameter of the shell; posteriorly the hinge-line forms an obtuse angle with the posterior border. The umbones are anterior, not terminal.

The *interior* is unknown.

[1] Professor Geinitz writes me that he now considers this shell to be an *Estheria*. *See* 'Sitz. Isis,' 1879, No. 1, p. 10.

The *exterior* is marked with exceedingly close, fine, microscopic, thread-like striæ, which are closely crowded in front, but become parallel to the margin, and terminate in the upper border. Obscure radiating lines are sometimes present.

*Dimensions.*—Pl. XVI, fig. 19, measures—

| | |
|---|---|
| Antero-posteriorly . . . . | 10 mm. |
| Dorso-ventrally . . . . | 9 mm. |

*Localities.*—Scotland: Limehouse Water, near Mid Calder; Straiton oil shales near Burdiehouse; Shale, Inchkeith Island; Quarry, east of Binn Hill, Burnt Island, Fife; Middleton Pit, Uphall, Edinburghshire, all in the Cement Stone group near the horizon of the Burdiehouse Limestone; Wardie Shales, Water of Leith, Kates Mill, near Edinburgh at a lower horizon. England: Trafalgar Pit, Cinderford, Forest of Dean. Roof of Cannel Coal, Wigan. Spirorbis Limestone, Ardwick.

*Observations.*—Mr. Robert Etheridge, jun., who was the first to describe the shell now under consideration, drew attention to the close resemblance between it and *Anthracomya lævis* of Dawson. He states that "I was for some time quite at a loss how to distinguish between them; however, *A. scotica* is larger than the Nova-Scotian *Naiadites lævis*. Judging from Dr. Dawson's figure, the concentric striæ are also more numerous, finer, and closer; the posterior end appears to be more obliquely truncate, and the beaks are more anterior." These distinctions seem to me to be due to a large extent to a difference in size, and hardly to be characters of specific value. I have had the opportunity of examining specimens of the Nova Scotian form, and those that I have seen are only half the size of the Scotch examples, and are, as Mr. Etheridge states, somewhat more oblique, and the striæ are finer and closer. From a study of young and adult forms of this genus the growth always appears to be more rapid towards the posterior end, and the tendency is for shells as they increase in size to become less oblique. It would be natural, too, to suppose that in the smaller examples the lines of growth would be finer and closer. I have, therefore, considered it best to retain Sir W. J. Dawson's name of *lævis* for this shell, adding the name *scotica* as denoting a large variety. Mr. Salter (*op. cit.*, p. 80) identifies Dawson's shell with one found in the Upper Coal-measures of the neighbourhood of Manchester. This may perhaps be the form named *Unio rugulosus* of Phillips, the description of which seems to agree very well with *A. lævis*. Should this be the case, the name *rugulosus*, dating 1839, must supersede all others. The description of *U. rugulosus* is "of obliquely expanded or semi-elliptical form. The hinge-line forming the diameter [of both valves]. Surface concentrically marked with broken undulations, often showing radiations on the posterior slopes. Shell exceedingly thin." ('Sil. Syst.,' p. 88.)

Mr. Etheridge, jun., also queries whether Hibbert's *Unio nuciformis* may not

be the uncrushed form of his *A. scotica*. On this point it is impossible to give an opinion, as the original shell has completely disappeared.

Mr. Etheridge, jun., drew attention to the close resemblance between Ludwig's *Anodonta obstipa* and his species of *A. scotica*. This is very apparently so, but it is unsafe in the case of crushed and flattened shells to be too dogmatic. Ludwig shows that his specimen possessed a microscopically reticulated surface which, while it agrees with Dr. John Young's prismatic cellular structure of Naiadites and other Mytiliform shells, also partakes of the character which Prof. T. R. Rupert Jones considers ('Geol. Mag.,' 1870, p. 217) "very unusual in molluscs, but common in Estheria."

Prof. Rupert Jones, however, later pointed out that Dr. John Young had demonstrated to him that shells in the genera Anthracoptera [Naiadites], Posidonomya, Pinna, Pteronites, Myalina, Aviculopecten, &c., possess a reticular punctate surface ('Trans. Geol. Soc.,' Glasgow, 1890, p. 86), and he affirms the molluscan character of some shells previously considered to be crustacean. Judging from the figures and description, *Cardinia Freystenii* of Prof. Geinitz ('Die Versteinerungen der Steinkohlen-Formation in Sachsen,' 1855, p. 2, pl. xxxv, fig. 7 *a*, A) might be mistaken for *A. lævis*, var. *scotica*, but it is somewhat larger, the measurements given being 13 mm. long by 11 mm. high. I can distinguish no other difference between this shell and the types of Mr. R. Etheridge, jun.; but Professor Geinitz writes me that he now considers this shell to be an Estheria, and if this be the case of course there is no question of nomenclature involved; but should this shell have been wrongly referred to Estheria, the specific name *Freystenii* is anterior to others.

I have figured, Pl. XVI, fig. 23, an example of *A. lævis* from the South Joggins Coal-field of Nova Scotia, that it may be compared with the British forms.

Fig. 20, Pl. XVI, shows an unusual character in the sinuosity of the posterior border just below the posterior superior angle, a condition more typical of the genus Naiadites. It is impossible, owing to the crushed state of the specimen, to pronounce with absolute certainty on the genus, but the general facies of the shell is that of *Anthracomya lævis*, var. *scotica*, and not of Naiadites.

*A. lævis*, var. *scotica*, approaches *A. Phillipsii* more closely than other forms; this may be, however, because both forms are met with crushed flat, and we are really almost in ignorance as to the contours of the shells. Both species were very gregarious, and though they existed for a long period, yet they had only a limited horizontal distribution.

## *Family* MYTILIDÆ.

### *Genus* Naiadites, *Dawson*, 1860.

G. F. Myles, 'Memorabilia Saxoniæ Subterraniæ,' p. 39, pl. xxvi, fig. 10, 1720.

*Synonyms:*

*Modiolus*, Fleming, 1825.
*Mytilus*, Fleming, 1828.
*Modiola*, Sowerby, 1840.[1]
*Mytilus*, Sowerby, 1840.
*Avicula*, Sowerby, 1840.
[No name], R. Garner, 1844.
*Modiola*, Brown, 1849.
*Avicula*, Brown, 1849.
*Mytilus*, de Ryckholt, 1852.
*Modiola*, Lea, 1853.
*Dreissenia*, Ludwig, 1859–61.
*Myalina*, McChesney, 1860.
— Meek and Worthen, 1860.
*Naiadites* (pars), Dawson, 1860.
*Myalina*, Salter, 1861.
*Anthracomya?* Salter, 1861.
*Anthracoptera*, Salter, 1862.
*Anthracomya*, Hull, 1873.
*Myalina*, R. Etheridge, jun., 1875.
*Anthracoptera*, R. Etheridge, jun., 1875.
— Ward, 1875.
*Myalina*, Kirkby, 1880.
*Conocardium*, Achepol, 1880–83.
*Dreissenia*, Achepol, 1880–83.
*Mytilus*, Achepol, 1880–83.
*Myalina*, Barrois, 1882.
*Anthracoptera*, Hind, 1893.
*Naiadites*, Hind, 1894.

*Generic Description.*—Shell modioliform, obliquely triangular, very unequilateral, close all round; inequivalve, the left valve being the more tumid, the right valve flattened. Both valves notched for the byssus, the left one being so cut to a greater extent. The anterior end is oblique, forming a small lobe anterior to the umbonal ridge. There is always present a more or less defined oblique ridge passing from the umbones backwards and downwards, most marked in the left valve. The hinge-line is straight. The hinge-plate is striated, and possesses in front an obscure cardinal tooth, that of the left valve being anterior, and that in the right posterior. The umbones are almost terminal, and generally pointed forwards. The shell is strong and even massive anteriorly, becoming gradually thinner posteriorly, till at the extreme end it may be very fragile. The surface is furnished with flat concentric lamellæ, and lines of growth. Periostracum thick and wrinkled. Anteriorly the lines of growth are close and crowded, but they separate as they pass backwards and become distinct; and when they reach the oblique ridge they become reflected rapidly upwards towards the hinge-line. I have seen no trace of internal or external ligament, but the place of

[1] *See* foot-note, p. 83.

a ligament was taken by the fibro-cartilage which was attached to the striations on the hinge-plate.

*Interior.*—The pallial line is represented by a series of small pits and is not sinuated. The posterior adductor scar is almost circular, large, and situated near the posterior border. The anterior adductor scar is small, pit-like, and is situated within the beak somewhat anterior to the umbo. There are two accessory pit-like scars for the pedal and anterior byssal muscle; one is umbonal, and the other is midway between the umbo and the anterior adductor scar. The scars for the byssal muscles are almost obsolete.

*Observations.*—In the very first work that I can find on the subject of fossil bivalves from the Coal-measures, by G. F. Myles, dated 1720 (*op. supra cit.*), figures are given of the genus Naiadites, but unfortunately no name was given to them (*vide antea*, p. 12). Since that time the genus has passed through many changes in nomenclature, and it has been a matter of some little difficulty to decide as to the priority of the different claims. Except in one case, authors have always referred the shells of this genus to one of two families, the Aviculidæ and the Mytilidæ; the exception being in the case of Achepol, who referred specimens to Conocardium, a genus which has really no characters in common with Naiadites. The reference to Avicula was made only by two authors; one of whom was J. de Carle Sowerby, and the other Captain Brown, who simply repeated Sowerby's figure and description.

Sowerby curiously enough described four species of this genus under three different generic names in the same publication ('Geol. Coalbrookdale'); namely, Modiola, Mytilus, and two under Avicula, all four figures being good and characteristic. The genus Naiadites can easily be separated from Avicula, as it possesses no ears nor cartilage-pit, and the valves, though unequal, are not greatly so. The general shape, too, is very dissimilar.

To Modiola and Mytilus the genus Naiadites seems to be very closely related, but it has certain distinctive characters which separate it from both of them. From Modiola, Naiadites is distinguished by the possession of a striated hinge-plate, the absence of an internal ligament, and by being less transversely produced. From Mytilus Naiadites is separated by the non-terminal umbones, the absence of internal ligament, and the striated hinge-plate. The possession of this latter character points to the fact that Naiadites is intermediate between the Aviculidæ and the Mytilidæ.

Ludwig referred his specimens of Naiadites to Dreissenia, to which genus there is a very close external resemblance, both in shape and ornament; but Dreissenia possesses an internal septum in the beaks, which I have never seen to occur in Naiadites; and in Dreissenia the posterior adductor muscle is riband-like and

flat, and is inserted into the shell close to the upper border, whereas it is thick and obovate in Naiadites.

Many authors have referred specimens of this genus to Myalina, de Koninck; but this author states in the original description of this genus, "À l'intérieur et immédiatement au-dessous de ceux-ci (les crochets), une petite lame septiforme, semblable à celle qu'lon observe dans certaines espèces de Mytilus." As I have mentioned above, if Myalina has this septum, Naiadites is at once distinguished by its absence, although Myalina is said to possess a striated hinge-plate. The shells from the Permian of Durham called *Myalina squamosa* and *M. septifera* undoubtedly have this septum, and possess the other characters of Myalina enumerated by the author of that name.

In the 'Geological Magazine,' 1893, vol. x, dec. 3, p. 514, I published a note on the *Myalina crassa* of Fleming, showing that this shell could not be separated from the genus Anthracoptera (Naiadites) by any one character. M. Barrois ('Recherches sur les terrains anciens des Asturias et de la Galice,' p. 334) remarks on this close resemblance between Myalina, de Koninck, and Anthracoptera, Salter, and thinks it impossible to distinguish between them; he therefore describes his species as *Myalina carinata* and *M. triangularis*, thus making Myalina synonymous with Anthracoptera; but he did not notice that the lamelliform myophore of Myalina was absent in his specimens. De Koninck also says his shell is "equivalve," a character which does not agree with the genus under description. This fact is referred to by M'Coy, 'Brit. Pal. Foss.,' p. 491, note, who quotes and agrees with Professor King, who had stated that the genus Myalina was inequivalve.

American palæontologists have always named their Mytiliform Carboniferous shells Myalina, and indeed prior to his note on these shells in the 'Geol. Surv. Memoir, Geol. Country around Wigan,' 2nd edit., 1862, p. 371, giving the diagnosis of his new genus Anthracoptera, Mr. Salter ('Iron Ores of South Wales,' p. 229) had said, "They have been referred to Avicula, but are probably Myalina;" and he figures the *Avicula modiolaris* of Sowerby as Anthracomya in pl. ii, fig. 13.

Mr. Salter's diagnosis of the genus Anthracoptera is as follows:—"They have neither the unequal valves of Avicula nor the striated hinge-plate of Myalina, nor indeed any hinge-plate at all. There is a very obscure tooth in the anterior part of the hinge, but only a thickened margin to the hinge-line, and no lateral tooth at all," &c.

This statement I showed to be incorrect ('Quart. Journ. Geol. Soc.,' vol. xlix, p. 250, pl. vii, figs. 1, 1 *a*, 1 *b*, 2, 2 *a*), for there is no doubt as to what shells Mr. Salter referred to, and his Anthracoptera is now known to possess a well-marked striated hinge-plate, unequal valves, and an obscure anterior tooth (Pl. XVII,

figs. 8—10, 12—15); but at that time I kept Mr. Salter's name. On the publication of this paper Sir W. J. Dawson wrote to me that he considered his name Naiadites, published in the Supplementary Chapter, 'Acadian Geology,' 1860, p. 43, had prior claim to Mr. Salter's Anthracoptera, and that he had had some correspondence with him on the subject; so much so that when Salter was describing some remains from the South Joggins Coal-field, 'Quart. Journ. Geol. Soc.,' vol. xix, p. 80, 1863, he figured some specimens which W. J. Dawson had sent him as Anthracomya (Naiadites) and Anthracoptera (Naiadites). In the next edition of the 'Acadian Geology,' 1868, p. 204, we find W. J. Dawson refers his shells to Naiadites (Anthracomya), and Naiadites (Anthracoptera).

Under the term Naiadites were described and figured seven shells, the first only really belonging to Mr. Salter's genus, the majority belonging to Anthracomya, and one only to Carbonicola. Under these circumstances Sir W. J. Dawson and I agreed to substitute his name of Naiadites for Mr. Salter's Anthracomya, and we placed before the Geological Society a joint note to this effect; but it was pointed out that the name should be retained for the first shell in the list rather than for the majority. This shell happened to be *Naiadites carbonaria*, and consequently I altered my note to suit this view, and replaced Mr. Salter's genus of Anthracoptera of 1862 by Sir W. J. Dawson's Naiadites of 1860. The question then arose as to whether de Koninck's Myalina might not even supersede Naiadites, as from my discovery of the striated hinge-plate, the great point on which Mr. Salter relied for separate diagnosis was removed; but there still remained the fact that de Koninck affirmed a rostral plate or myophore in his description, which was, however, conspicuously absent in his figures, and more markedly so in the illustrations in pl. xxix of his later work, 'Faune du Calcaire carbonifère de la Belgique,' 1885. In the text he states, p. 168, "J. W. Salter a créé en 1863 pour quelques espèces mytiliformes provenant des assises inférieures de terrain houillier, le genre Anthracoptera; celui-ci a aussi beaucoup d'analogie avec le genre Myalina, mais sa charnière est égalment mince et linéaire et son ligament est externe." This is rather a curious remark, as a few lines above he had stated, "Bord cardinal epais, plat, avec plusieurs rainures longitudinales de cartilage."

It is quite possible that all de Koninck's species of Myalina differ from those of Naiadites, as the former are all stated to be from the Calcaire carbonifère of Visé, where they are associated with a typical marine fauna. M'Coy ('British Palæozoic Fossils,' p. 492) says in his description of Myalina there is "a triangular septum in the cavity of each beak, parallel with the plane of the lateral margins (leaving deep slits under the beaks of the casts)," but he makes no mention of specimens of this genus from British Carboniferous rocks. I have therefore adopted the name Naiadites (Dawson) for the Mytiliform shells of the Coal-measures for a twofold reason. First, because they do not possess myophorial septa; and second,

because they do not occur with a typically marine fauna as a rule,—the one possible exception being the *Naiadites crassa* of the Beith and Pitlessie beds, and I am in doubt as to the real conditions under which these deposits were laid down.

At Pitlessie the shells are accompanied by Stigmaria and other vegetable remains, scales of Megalichthys and Spirorbis, together with Aviculopecten, Encrinites, and corals. The shells are in a much disturbed state, and very few are whole or possess the valves in contact; and with such a mixed fauna and flora, the bed may well have been the result of a wash; but, as I have remarked, very many shells exhibit fractures repaired during life. It is not at all impossible that *Naiadites crassa* was of marine habitat, and that the dwarfing of the other members of the genus may be due to a change of condition of environment. At Beith, the other habitat of this shell, it is found in a bed resting on coal associated with fish remains. Here the shell is in a somewhat better preserved state, the valves often being in contact; the evidence shows that at this place the shell was truly marine; certainly its extremely local occurrence is very marked. The three pit-like muscular scars within the anterior part of the shell are characteristic of the genus. It is difficult to be accurately certain as to the several muscles which each represents. The anterior two pits are much larger than the posterior, and possibly represent a bifid anterior adductor, while the posterior pit represents the attachment of the long anterior byssal muscular bundle. M'Coy ('British Palæozoic Fossils,' p. 492), speaking of Myalina, says, "The small impression over the large anterior adductor I find (in the recent Mytili with rostral plates) is the scar of the insertion of the adductor from the opposite valve, instead of retractors of the foot, as commonly supposed, the larger impression being the scar of origin thereof." My own dissections of *Dreissenia polymorpha* hardly bear out this, but Professor M'Coy may be referring to *Mytilus bilocularis* (*Septifer*, Recluz), with which I am not acquainted.

Mr. Salter mentions the fact of this genus, Anthracoptera, possessing in front an obscure tooth in the hinge; it is curious, if he had good enough specimens to ascertain this fact, that he did not notice the striated hinge-plate. The tooth is very obscure in the smaller species, but even in these it is to be made out in well-preserved examples. It is to be seen in the specimens figured on Pl. XVII, fig. 15; Pl. XIX, figs. 1—7.

The striated hinge-plates seem to have been in contact in the smaller forms to such an extent that nothing whatever of them was visible when the valves were together, but in the larger shells of *Naiadites crassa* this hinge-plate is at such an angle that the valves could only have been in contact along the lower border, leaving an elongate pit, triangular in section, which lodged the cartilage; and it is, of course, in the larger species a mechanical necessity that the hinge-plate

should have been bevelled at the expense of this upper surface, in order that the valves might open.

The genus Naiadites was gregarious in its habit, and attached itself by the byssus to pieces of wood or other shells; masses are often found together.

There is in the British Museum (Nat. Hist.), Cromwell Road,[1] an interesting slab from the shale above the Kinderscout grit of Rabchester, Lancashire, on which is shown a piece of wood surrounded on three sides by masses of Naiadites two and three deep, lying in many cases with their inferior borders towards the wood, as if attached to it by the byssus. This habit and the possession of a byssus precludes the idea that these shells were burrowers; and an additional piece of evidence is the frequent presence of Spirorbis even on those shells which have the periostracum preserved. It is only a reasonable inference, too, to suppose that the shells of Carbonicola and Anthracomya, which nearly always occur with Naiadites, and under similar conditions as to the presence of Spirorbis, were not of a burrowing habit.

Dr. John Young, of the Hunterian Museum, Glasgow, has made out that the genus Naiadites possesses, in common with the Aviculidæ, Pinnæ, and others, an outer layer of prismatic cellular structure. He read a note[2] of this discovery before the Glasgow Geological Society on January 13th, 1880. He says, "So far as I have examined my Carboniferous Lamellibranchs, I find that this prismatic structure is confined to shells belonging to the Aviculidæ . . . and the Mytilidæ."

I figure on Pl. XVII, fig. 11, a portion of a shell of Naiadites from the Coal-measures of Knightswood, N.W. of Glasgow, which shows this structure.

R. Ludwig had as long ago as 1863 pointed out the similar structure in a shell which he calls *Anodonta obstipa* ('Palæontographica,' Bd. x, pl. iii, figs. 2 *h*, *f*, ×100) from the left bank of the Uswa, near Nischni, Parogi, Perm. This shell has the appearance of an Anthracomya, in which genus, Dr. Young says, he has not been able as yet to demonstrate prismatic structure.

1. Naiadites modiolaris, *Sowerby*, 1836–40. Plate XVII, figs. 8—10, 12—30.

Avicula modiolaris, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 18, read 1836, pub. 1840.
No name. *R. Garner*. Nat. Hist. of County of Stafford, pl. E, figs. 21, 22, 1844.
Avicula modiolaris, *Brown*. Fossil Conch., p. 162, pl. lxi **, figs. 23, 24, 1849.
Modiola funata, *Brown*. Ibid., p. 172, pl. lxxi, figs. 12, 13.
— subtruncata, *Brown*. Ibid., p. 173, pl. lxxii, figs. 15, 16.

[1] 'Geol. Mag.,' dec. 3, vol. x, 1894, p. 540.

[2] "Notes on some Carboniferous Lamellibranchs, their Mode of Occurrence and Observed Shell-structure," 'Trans. Geol. Soc. Glas.,' vol. vi, 1890, p. 223.

MYTILUS WESEMAELIANUS, *de Ryckholt*. Mélanges paléontologiques; Mém. Couronn. Acad. Roy. Belg., vol. xxiv, 1852, p. 140, pl. viii, figs. 11, 12.

MODIOLA WYOMINGENSIS, *Lea*. Journ. Acad. Nat. Sci. Philad., new ser., vol. ii, pt. 3, p. 203, pl. xx, fig. 1 *a*, 1853.

DREISSENIA LACINIOSA, *R. Ludwig*. Palæontographica, vol. viii, p. 38, pl. v, figs. 15, 19, 1859.

— INFLATA, *R. Ludwig*. Ibid., vol. viii, p. 190, pl. lxxi, figs. 8—10, 1861.

— DILATATA (pars), *R. Ludwig*. Ibid., p. 189, pl. lxxi, figs. 5—7.

MYALINA MODIOLARIS, *Salter*. Geol. Surv. Mem., 'Iron Ores of South Wales,' p. 228, pl. ii, fig. 14, 1861.

ANTHRACOMYA? MODIOLARIS, *Salter*. Ibid., p. 230, pl. ii, fig. 14.

— — *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, 1890, p. 125, pl. i, fig. 13, 1890.

ANTHRACOPTERA MODIOLARIS, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 251, vol. vii, figs. 1, 1 *a*, 1 *b*, 3—6, 1893.

*Specific Characters*.—Shell obliquely elongated, compressed posteriorly. The hinge-line is straight, nearly or quite as long as the greatest length of the shell.

The anterior part of the shell is represented by a small gibbose lobe, which projects forwards with a rounded border, which becomes concave below, and is pierced by the byssus. The posterior part forms the greater portion of the shell; it is produced downwards and backwards, expanded, and gradually compressed into the margin. The posterior border is bluntly curved, but it may be straight or even emarginate, and meets the hinge-line at an angle which is either greater than or equal to a right angle. The junction of the inferior and posterior borders is bluntly curved. The umbones are anterior, not quite terminal, and on reaching the hinge-line are curved forwards and inwards, not contiguous, slightly elevated above the hinge-line. An acute and prominently swollen ridge, flatter in young specimens, passes obliquely backwards and downwards, and, while preserving its character in the anterior two-thirds, rapidly becomes lost in the lower and posterior third. Anterior to this oblique ridge the shell is markedly constricted, often becoming slightly concave. The ridge is bent forwards in front, and is parallel to the hinge-line. It is much more pronounced in the left valve. The right valve is much flattened.

*Interior*.—The anterior muscle-scars are three in number, pit-like; the anterior markedly the largest, and situated within the umbo; the next is situated just below the horizontal part of the ridge (in casts), while the posterior scar is on the right exactly at the point where its direction becomes changed downward. The posterior scar is large and obovate, situated close to the posterior superior angle of the shell. Faint traces of the attachment of byssal muscles are occasionally seen near the upper border. Two or three slight

diverging grooves are seen on the posterior slope, which apparently rise from the upper part of the keel, and are seen as ridges in casts. The hinge-plate is striated (in some specimens with as many as ten striæ) in the anterior two-thirds; it then becomes narrowed as it passes backwards, and finally at about half the length of the hinge-line disappears, and the flattened and thinned upper border of the opposite valve comes in contact. The lowermost striæ are the most prolonged, the hinge-plate being thickest at the anterior end. In front above the striæ of the hinge-plate is seen the inner surface of the umbo, which overlaps slightly inwards in young and unworn specimens. These striæ appear to represent the bevelled edges of the plates of which the shell is composed, having been deposited in succession from the mantle, and the innermost being the largest. They can be traced downwards for a short extent into the anterior border, but soon become lost, and have entirely disappeared at the byssal notch.

*Exterior.*—The surface is ornamented with striæ and lines of growth; the striæ may almost be said to be obsoletely imbricated. These lines of growth arise at the apex of the shell, and are densely crowded. They pass downwards parallel to the edge of the shell with a slight divergence until they reach the oblique ridge, when they become separated by wider and regular intervals, and, reflected rapidly at a right angle, they pass across the posterior part of the shell to the superior border. Periostracum thick and wrinkled. Shell thick relatively to its size. Its greatest thickness is

*Dimensions.*—Pl. XVII, fig. 17:

| | |
|---|---|
| Greatest antero-posterior . . . | 32 mm. |
| Greatest dorso-ventral . . . | 21 mm. |
| Greatest thickness . . . . | 14 mm. |

*Localities.*—England:—The roof of the Hard-mine, Banbury, Holly Lane, and Moss on Easling Coals, and Knowles or Winghar and Burnwood Ironstones of North Staffordshire. White flats; Coalbrookdale. Thirty feet below the Arley Mine, Rochdale. Stubb's Mine, Ashton-under-Lyme. Above the Shale Coal and Stanley Main, Wakefield. Above the Brockwell Seam, Wigglesworth. Codnor Park, Derbyshire. South Wales:—Darren Pins. Scotland:—Annandale; Kilwinning; Shotts; Shettleston; Splint Coal, near Glasgow; Clyde Pits.

*Observations.*—This species was first described under the generic name of Avicula by Sowerby (*op. supra cit.*). Captain Brown, in the 'Fossil Conchology,' copied Sowerby's descriptions, adding only a few words, but gave entirely different figures. He then figured and described under the names *Modiola funata* and *M. subtruncata* forms which are so much like the original drawings of Sowerby that I have given them as synonyms. This generic reference was, however, much more correct than the original one of Avicula.

I have very little doubt that the *Mytilus Wesemælianus* of de Ryckholt from

the Coal Shale of Mons should be referred to the species under discussion. His description is "Coquille un peu triangular, anguleuse, très-inéquilateral, rétrécie et émousée en arrière, dilatée et arondie en avant; . . . . côté cardinal droit; région du ligament comprimée; région palléale renflée," which corresponds very well with that given above. Isaac Lea gives a typical figure of *Naiadites modiolaris* under the name *Modiola Wyomingensis* (*op. supra cit.*) from the Coal-measures in the neighbourhood of Wilkesbarre. His description is "Testâ lævi triangulari infernè compresso-alatâ; umbonibus elevatis acutè angulatis;" and he remarks, "This is a broad, flat species." Scales of Palæoniscus occurred with the shells.

Ludwig appears to have divided this species into three, to each of which he gave names, apparently unaware that Sowerby and Brown had already done the same thing between them, and to an equal extent. I have had the good fortune in this case to see the original specimens now in the Museum at Dresden, and find that the fossils so beautifully drawn are embedded to a large extent in the matrix and are very imperfect. I was unable to see on what grounds *Dreissenia luciniosa* was divided from *Dreissenia dilatata*. The former is said to be sharply triangular "am unteren Ende dreizipfelige," while *D. dilatata* is "unten stumpf zugerundete;" but in many cases the shells are so compressed and distorted as to render it unsafe to erect species upon them. Fig. 10, pl. xxi, *op. cit.*, the drawing of *D. inflata*, is a pure invention, the specimen being not a fossil at all, but a clay-ironstone concretion. It is noteworthy of Mr. Salter's great uncertainty of the real affinities of some of the Coal-measure shells that in the Geological Survey Memoir 'The Iron Ores of South Wales,' on p. 228, he gave "*Myalina modiolaris* (*Avicula*, 'G. Tr.,' pl. xxxix, fig. 18), pl. ii, fig. 14," and on p. 230, "*A.* ? sp. (*Avicula modiolaris*, Sow.), pl. ii, fig. 14, aberrant form;" thus referring the figure of one shell to two different genera. The "diagram of the general shape and characters" of Anthracoptera, given with his original description by Mr. Salter, 'Memoirs Geological Survey, Great Britain,' "Geology of the Country around Wigan," 2nd edit., Appendix, p. 38, 1862, might have been drawn from a typical specimen of *N. modiolaris;* it possesses the emarginate posterior border which would become trifid if the shell were flattened, and would appear like Ludwig's *Dreissenia luciniosa*. This condition is very rare, being naturally absent in casts, and, owing to the extreme fragility of the shell at the posterior border, is rarely preserved except in specimens crushed flat in the shale. The presence or absence, then, of this emarginate posterior border is not of specific value, being present or absent according to the state of preservation of the fossil. In the same volume and on the same page from which I have just quoted Mr. Salter describes a new shell as *Anthracoptera ? Browniana*, with which he states *Avicula tenua*, referred to by Mr. Binney in the 'Manchester Geol. Trans.,' vol. i, p. 161, pl. v, fig. 23, and described by Brown in 'Foss. Conch.,' p. 161, pl. lxviii, fig. 9, is

synonymous. Of this shell he gives the following description :—"It is exceedingly thin, almost papery in texture, and so little can be seen of the hinge or muscular impressions that I do not feel sure it belongs to the genus here for the first time proposed." This speaks for itself, and a comparison of Captain Brown's with Mr. Salter's half-real, half-ideal figures will render the species *Anthracoptera Browniana* of Salter exceedingly problematical. There exists, as far as I can see, no excuse for the change of Captain Brown's specific name of *tenua*, which had not been appropriated in Mr. Salter's new genus. I suspect that Captain Brown's shell will probably turn out to be Posidonia, which is very abundant in some beds of the Lancashire Coal-field. I would point out, too, that Captain Brown represented his specimens as perfect; but Mr. Salter, to transform the shell into his new genus, dotted in a hypothetical outline. In most museums and collections the name *Anthracoptera Browniana* was given to such flattened and crushed specimens as were too imperfect to identify with other forms. I have therefore seen no reason for retaining a name, in respect of which even the author himself seems to have had considerable doubt.

Mr. John Ward's determination of *Naiadites modiolaris* as *Anthracomya modiolaris* is evidently due to Mr. Salter's misleading statement quoted above, for the figure in the 'Iron-ores of South Wales' is referred to in support of his opinion.

*Naiadites modiolaris* is somewhat variable in shape, but always is more nearly a right-angled triangle than any of the other species of this genus. The hinge-line may be as long as, longer than, or even less than the greatest length of the shell; this may be due, as I have pointed out above, to the accidental non-preservation of this posterior edge of the shell; the variation also from the angle made by the junction of the posterior and superior borders to a blunt curve is probably due to the same cause, *i. e.* casts of the interior do not show the extreme length or accurate shape of the posterior end, for here the two valves came absolutely into contact.

2. Naiadites triangularis, *Sowerby*. Plate XVII, figs. 31—38.

Mytilus triangularis, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 16, 1840.

— Toilliezianus, *de Ryckholt*. Mélanges Paléontologiques, p. 141, pl. viii, figs. 13, 14, 1852.

— ampelitæcola, *de Ryckholt*. Ibid., p. 143, pl. viii, fig. 17.

Myalina Swallovi, *McChesney*. New Sp. Palæozoic Fossils, p. 57, pl. ii, figs. 6, 6 *a*, 1860.

— — *Meek and Worthen*. Geol. of Illinois, Palæontology, vol. ii, p. 341, pl. xxvii, figs. 1 *a*—*d*, 1866.

? Myalina triangularis, *Barrois*. Recherches sur les terrains anciens des Asturies et de la Gallice, p. 336, pl. xvi, fig. 14, 1882.

Anthracoptera triangularis, *Hind*. Quart. Journ. Geol. Soc., vol. lxix, p. 253, pl. vii, figs. 7—9 *a*, 1893.

*Specific Characters.*—Shell mytiliform, compressed obliquely, obovate with a pointed anterior end, and the posterior wall, much flattened and produced obliquely downwards and backwards, comprising the greater part of the shell. The posterior border is regularly curved almost in a semicircle, and it passes imperceptibly into the upper and lower borders. The hinge-line is straight, equal in length to about one-third of the greatest length of the shell. At the posterior end of the hinge-line the superior border of the shell slopes downwards and backwards, passing gradually into the posterior border with a gentle curve. The inferior border is very oblique and nearly straight. The byssal notch is situated at the junction of the anterior and middle thirds. The umbones are not so tumid as in the preceding species, but similar in shape and direction. An oblique ridge passes obliquely downwards and backwards, but soon becomes lost on the surface of the shell.

Interior and external markings as in *Naiadites modiolaris*.

*Dimensions.*—Fig. 31, Pl. XVII, measures—

| | |
|---|---|
| Greatest antero-posterior . . . | 38 mm. |
| Greatest dorso-ventral (close to posterior end) . | 21 mm. |
| Thickness . . . . . | 10 mm. |

*Localities.*—England:—Roof of the Hard-mine Coal, North Staffordshire. Grains Ironstone, South Staffordshire. Crawstone, Coalbrookdale. Blue Vein, Ebbw Vale. Scotland:—Shotts.

*Observations.*—This shell only differs from *Naiadites modiolaris* in shape, and is distinguished by its flatter form and the shape of the posterior end; a greater amount of growth having taken place towards the posterior inferior extremity, with the result of making the hinge-line much shorter than the extreme length of the shell. It is very doubtful whether this condition should be regarded as of specific value, but I have retained the name for the present because it is quite easy to distinguish between the two forms, and typical young examples occur along with the adults. At the same time it is true that many specimens occur which it is difficult to determine, and a series might easily be figured connecting the forms *N. modiolaris* and *N. triangularis* on the one hand, and *N. triangularis* and *N. carinata* on the other. Sowerby's original figure was from an imperfect specimen, which I am unable to trace. This was incomplete at the posterior superior angle, and a hypothetical outline was dotted in. This specimen must have been juvenile, for its extreme antero-posterior measurement is only 18 mm.,

and the dorso-ventral measurement is only 8 mm., so that the shell is long compared to its depth.

The description given is meagre, being "Triangular, with a rounded front, rather flattened, keeled towards the beaks." It is therefore a question as to which adult forms should be referred to under this name. Judging from shape alone, *N. modiolaris* merits the term triangular, but the much greater comparative dorso-ventral measurements, and the fact that Sowerby's original figure of *Avicula modiolaris* is very typical of that form of the shell which possesses a hinge-line somewhat shorter than the length of the shell, make it impossible to consider that the more triangular forms of this shell should be referred to *N. triangularis*. Again, emphasis is laid upon the fact that the shell is rather flat, and the drawing agrees with this description, and this prevented me from referring the new species, what I named *Naiadites elongata* in 1883 (*op. infra cit.*), to Sowerby's shell. In *N. elongata* the hinge-line is long and the shell transverse, but it is very much swollen in its entire length (Pl. XVIII, fig. 31).

In young and medium-sized specimens of *N. triangularis* (Pl. XVII, fig. 38) it is comparatively easy to imagine that the whole of the superior border is hinge-line, as, owing to the very gradual slope of the posterior part of the shell, the line of the hinge and posterior edge of the shell appear to be continuous; but on careful inspection this is seen not to be so. The hinge-line is comparatively short and the posterior border begins to fall away at once. This is shown in Sowerby's drawing, 'Trans. Geol. Soc.,' ser. 2, vol. v, pl. xxxix, fig. 18, left-hand figure, and the dotted line is carried forwards past the point to the posterior extremity of the hinge, and a fictitious posterior end, in its upper part, depicted. In young shells the posterior end is more truncate and less rounded (Pl. XVII, figs. 36 and 38), and the anterior end more lobe-like and pronounced.

*Myalina Swallovi* of McChesney, Meek and Worthen, is, I think, doubtless referable to *N. triangularis*. They figure a full-grown form not to be distinguished from the specimen I figure (Pl. XVII, fig. 36).

I think it probable that *M. Toilliezianus* and *M. ampelitæcola* of de Ryckholt should all be referred to *N. triangularis*, the two names being given to young forms having the anterior end lobe-like, as in Pl. XVII, fig. 36. The former is stated to have been obtained from the coal shales of Mons, the latter from "l'ampélite alumineux" near Liége.

The figure given by M. Barrois is not like the original; it is subquadrate in shape, and in no way transverse, resembling rather a young specimen of *N. quadrata*.

*Naiadites triangularis* is to be distinguished by its obliquely triangular, flattened form, short hinge-line, and gradually curved posterior end, and by the oblique ridge extending only a short distance across the shell.

3. Naiadites carinata, *Sowerby*, 1836–40. Plate XVIII, figs. 1—16.

Modiola carinata, *Sowerby*. Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 15, 1836–40.

No name. *R. Garner*. Nat. Hist. of the County of Stafford, pl. E, fig. 19.

Modiola carinata, *Brown*. Foss. Conch., p. 175, pl. lxi ***, figs. 19, 20, 1849.

Mytilus Omaliusiana, *de Ryckholt*. Mélanges Paléontologiques, p. 144, pl. viii, figs. 22, 23, 1850.

— Mariæ (divisus), *de Ryckholt*. Ibid., p. 142, pl. viii, figs. 15, 16.

Dreissenia Feldmani (pars), *Ludwig*. Palaeontographica, Bd. viii, p. 188, pl. lxxi, figs. 3, 4, 1859–60.

— dilatata (pars), *Ludwig*. Ibid., p. 189, pl. lxxi, figs. 5 and 6.

Myalina carinata, *Salter*. Geol. Surv. Mem., "Iron Ores of South Wales," p. 228, pl. ii, fig. 15, 1861.

Anthracomya carinata, *Hull*. Coalfields of Great Britain, 4th edit., facing p. 38, fig. 3, 1873 and 1881.

Myalina carinata, *Barrois*. Recherches sur les terrains anciens des Asturies et de la Gallice, p. 336, pl. xvi, figs. 12 *a*, *b*, 1882.

Anthracoptera carinata, *Ward*. Trans. North Staff. Inst. Min. and Mech. Engin., vol. x, p. 129, pl. i, fig. 9, 1890.

— — *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 253, pl. vii, figs. 2, 2 *a*, 10, 10 *a*, 11, 12, 12 *a*, 1893.

— tumida (pars), *Hind*. Ibid., pl. vii, figs. 13, 13 *a*, 14.

*Specific Characters.*—Shell produced obliquely downwards, rhomboidal, and gibbose. The anterior lobe is comparatively larger than in other species. The anterior and posterior margins are almost parallel, the anterior being straight and slightly notched about its centre for the byssus, the posterior for the most part straight, but slightly convex below at the posterior inferior angle, and may be either straight or convex above, according as the angle formed by the junction of the superior and posterior borders is a right angle or greater than a right angle. The inferior margin is short and rounded, almost semicircular. The hinge-line is straight, about as long as any diameter of the shell parallel to it. The umbones are anterior, not quite terminal. They at first lie parallel to the hinge-line, but then become twisted outwards and are continuous with a sharp ridge which crowns a broad oblique gibbosity very much more pronounced in the left valve. This swelling and ridge pass downwards and backwards and become lost on the surface of the shell near the posterior inferior angle, the line of the ridge forming with the hinge-line an angle of 45° in most cases. The anterior part of the shell forms a small projecting lobe, and is swollen above, but becomes compressed obliquely parallel to and in front of the ridge. The posterior part of the shell is much compressed, especially above.

*Interior.*—The arrangement of muscle-scars, and the hinge-line, differ in no way from the descriptions given under *Naiadites modiolaris*, except that the posterior adductor scar is circular, and is situated just on the slope of the ridge about half-way down the shell.

*Exterior.*—The markings are precisely similar in character and arrangement to those which obtain in the preceding species.

*Dimensions.*—Pl. XVIII, fig. 1, measures—

| | |
|---|---|
| Greatest anterior posterior diagonal . . | 30 mm. |
| Length of hinge-line . . . . | 14 mm. |
| Thickness . . . . . | 11 mm. |

*Localities.*—England: Roof of the Hard-mine, Ten-foot, Holly Lane, Banbury and Moss seams; Knowles Ironstone, North Staffordshire; Grains Ironstone, and Queen's Cross, Dudley, South Staffordshire; Crawstone, Coalbrookdale, Doe Hill, and Butterley, Derbyshire; Stanley Main, Wakefield. Blue vein, and the Darrenpins, Sirrhowy and Cwm Ammon in South Wales. Scotland: The Middle Coal Measures of Shotts, Shelleston, and Kirkwood.

*Observations.*—Sowerby's original description of his *Modiola carinata* is:—"Obliquely elongated; valves boat-shaped, deep; anterior lobe small." This is somewhat vague, but the figure is typical, and it is to be noticed in looking at the list of synomyms that few authors have made use of any other specific name.

De Ryckholt does not seem to have been aware that anything had been published on coal-measure Lamellibranchs, and his original specimens seem to have disappeared; I could find no trace of them either at Brussels or Liége. *Mytilus divisus* of this author is figured as *Mytilus Mariæ*, a footnote in the letterpress pointing out this change. This shell is from the Carboniferous clay of Tournay, and is stated to be "un peu quadrilatère, renflée . . . côté anal élargi, se raccordant par des arcs de cercle obliques avec les côté cardinale et palléale; ces sont presque droits." This description is very characteristic of *Naiadites carinata*, and agrees so closely with it that there can be little or no doubt that both shells belong to the same species; but it is very questionable as to what may have been the shell called by de Ryckholt *Mytilus Omaliusianus*, which came from coal shale near Visé, and is said to have its "côté buccal coupé obliquement de bas en haut, côté cardinal arqué" (the figure shows it to be straight), and the shape of the shell is described as "un peu lancéolée . . . comprimée sur la region palléale, convexe partout ailleurs."

This species does vary in its shape and convexity, and a series of specimens can be obtained showing a gradual passage on the one side into *N. modiolaris* and *M. triangularis*. Indeed it would be perfectly justifiable to make them all into one species and give them their original names as varieties, seeing that they all seem to occur together, at any rate in the Hard-mine bed of North Staffordshire,

which is the source of hundreds of specimens which I have gathered and studied. I have not done this, wishing to avoid confusion and knowing that the names of these three forms have been in use for over half a century.

On looking over the originals of Ludwig's *Dreissenia dilatata* and *Dreissenia Feldmani*, I recognised some crushed forms which had I met with in England I should have referred to *N. carinata*, but it is most unsatisfactory to have to speak positively on crushed and imperfect specimens, and Ludwig's figures are utterly untrustworthy. At any rate there is no sufficient reason to establish new species of a genus which varies so much in shape as Naiadites on poor crushed specimens. Mr. Salter's figure in the 'Iron Ores of South Wales' is very good, and evidently similar to Sowerby's type in size and shape; the latter is, however, a little incomplete at the posterior superior angle. When I wrote my paper on the "Affinities of Anthracoptera" I had not been able to obtain access to Mr. Etheridge's type specimen of *Anthracoptera tumida*, and erroneously identified some very tumid examples of *N. carinata* with his species (*op. cit.*, pl. vii, figs. 13, 13 *a*, 14). These are to be distinguished by the marked constriction (byssal sinus) anterior to the oblique ridge, and by the oblique ridge appearing to more nearly bisect the shell, so that the anterior part, though not lobe-like, is large in proportion.

4. Naiadites quadrata (*Sowerby*). Plate XVIII, figs. 17—21, 23—25.

Avicula quadrata, *Sow.* Trans. Geol. Soc., ser. 2, vol. v, pt. 3, pl. xxxix, fig. 17, 1836–40.
— — *Brown.* Foss. Conch., p. 162, pl. lxi**, figs. 27, 28, 1849.
Modiola producta, *Brown.* Ibid., p. 173, pl. lxii, figs. 11, 12.
Myalina quadrata, *Salter.* Geol. Surv. Mem. of Gt. Britain, "Iron Ores of South Wales," p. 228, pl. ii, fig. 16, 1861.
? — subquadrata, *Shumard.* Palæontology Upper Missouri, p. 33.
? — meliniformis, *Meek and Worthen.* Palæontology of Illinois, vol. ii; Geological Survey of Illinois, p. 343, pl. xxvii, fig. 3, 1866.
Anthracoptera quadrata, *Hind.* Quart. Journ. Geol. Soc., vol. xlix, p. 254, pl. viii, figs. 1—4, 1893.

*Specific Characters.*—Shell compressed, produced downwards, quadrate or U-shaped, very slightly oblique. The anterior side is almost obsolete, and pointed forwards; the posterior expanded, often to a large extent, and flattened. The left valve is somewhat more convex than the right. The anterior margin is almost straight, and obliquely cut, there being about its centre, if anything somewhat

anterior to the middle point, a slight sinuosity marking the aperture for the byssus. The inferior border is narrow, being obliquely semicircular, and it passes into the anterior and posterior borders in front and behind without any angle, forming one general curvature. The posterior border is generally straight, and meets the posterior extremity of the hinge-line at an angle varying from rather less than 90° to 110°. The hinge-line is straight, as long as or slightly longer than the greatest diameter of the shell parallel to it. The umbones are small, inconspicuous, twisted forwards to be parallel to the hinge-line, not contiguous. From the umbones there proceeds a strongly-keeled oblique gibbosity which is directed downwards with a slight inclination backwards, and becomes expanded and lost on the surface after it has traversed about half the depth of the shell; this is less pronounced in the right valve. The posterior end is flattened and produced directly backwards.

*Interior.*—Owing to the anterior end being so little developed, as in *Naiadites modiolaris,* the three anterior muscle-scars are close together, and the posterior adductor does not seem to be relatively so close to the hinge-line. Hinge-plate thickened in front and striated.

Surface-markings as in the three previous species.

*Dimensions.*—Fig. 23, Pl. XVIII, gives the following details:

| | |
|---|---|
| Dorso-ventral . . . . | 32 mm. |
| Length of hinge-line . . . . | 22 mm. |
| Thickness . . . . . | 13 mm. |

*Localities.*—Roof of the Hard-mine, Ten-foot, and Banbury seams; Little-mine or Burnwood Ironstone Fenton; above the Woodhead Coal, Froghall, in North Staffordshire; Grains Ironstone, Oldbury, and Portway Hall, Dudley; White-flats and Pennystone, Coalbrookdale. Netherton, near Morpeth; Bunker's Hill, west of Rochdale, thirty feet below the Arley mine. South Wales: The Darrenpins. Scotland: Middle Coal-measures of Shotts.

*Observations.*—This form was considered by Sowerby to belong to Avicula along with *Naiadites modiolaris;* why, it is somewhat difficult to conceive. His original description was—"Quadrangular, convex, keeled; anterior lobe small, pointed; front rounded." The original specimen appears from the drawing to be incomplete at its posterior superior angle; but it has the oblique ridge directed almost downwards—what I regard as typical of this form. The word quadrangular is somewhat misleading, as the figure well shows the oneness of the curve of the inferior border with the anterior and posterior edges. The view in profile shows a thicker shell than I have met with in North Staffordshire.

Mr. Salter's figure from South Wales (*op. supra cit.*) is complete and very typical.

Captain Brown, in his 'Fossil Conchology,' copied Sowerby's figure and descrip-

tion, retaining the name Avicula, and this probably is the reason why he describes in the same volume a shell (*Modiola producta*) which from his figure I take to be the same as Sowerby's form. It is said to occur in coal shale at Wakefield, but no notice is given in the description of any definite shape or characteristics. The posterior end of Captain Brown's specimen was imperfect, so that it is impossible to give a dogmatic opinion as to the real nature of the shell. In my opinion it was either a large form of *N. carinata*, or more probably a specimen of *N. quadrata*.

With regard to the American specimens, I am judging from figures and descriptions only, for I have been unable to obtain access to forms from Missouri and Illinois. The figures and descriptions, however, show such a close connection with British forms that I have ventured to place *Myalina subquadrata* and *M. meliniformis* as doubtful synonyms of Sowerby's species *N. quadrata*.

This form is comparatively rare; it occurs on an average of only one to a hundred of the other species in the Hard-mine of North Staffordshire. The characteristic flattened U-shaped form with a much expanded posterior wing separate it from other species. The oblique ridge, too, is more nearly at a right angle to the hinge-line. It is connected with *N. modiolaris* on the one side and *Naiadites carinata* by a series of intermediate examples, forming with the three foregoing species one natural group which appears to be developing into four different distinct forms, characterised mainly by changes in the rate of growth of the shell at different points, the concomitant variations in anatomy depending on this.

5. Naiadites elongata, *Hind*, 1883. Plate XVIII, figs. 22, 26—35.

Naiadites elongata, *Hind*. Quart. Journ. Geol. Soc., vol. xlix, p. 256, pl. vii, figs. 15, 15 *a*, 16, 17, 1883.

Non — — *Dawson*. Acadian Geology, 1st edit., p. 43; 2nd edit., p. 202, fig. 43.

*Specific Characters.*—Shell tumid, modioliform, transversely elongated, only slightly equivalve. The anterior end is short and swollen, the posterior obliquely tumid below, flattened and compressed above so as to become concave between the hinge-line and the oblique gibbose keel, which passes downwards and backwards from the umbones to the posterior inferior angle, preserving its form, though somewhat expanded and less elevated to the edge of the shell. The anterior end has a blunt convex border, continuous with the inferior border, which is straight and directed downwards and backwards, having the byssal notch about the middle

point, the notch being chiefly in the right valve. The posterior border forms an obtuse angle above with the hinge-line, from which point it slopes downwards and backwards, becoming bluntly truncate below, or even subangular, where it comes in contact with the inferior border.

The hinge-line is straight, equal to about two thirds of the length of the shell, and would, if produced forwards, make a very acute angle with a line drawn in the direction of the inferior border. The umbones are obtuse, not quite terminal, produced forwards, non-contiguous, continuous below with the oblique ridge. The byssal furrow anterior to the ridge is oblique, broad, and much more marked in the right valve than in the left.

*Interior.*—The same conditions obtain in this form which I have noted in the preceding species, but the anterior muscle-pits are closer together and smaller on account of the size of the shell.

*Exterior.*—The lines of growth have the same general arrangement which exists in the other species of this genus, modified of course according to the difference of shape which is characteristic of the present shell, but on the whole the lines of growth are closer and more numerous than in other species.

*Dimensions* (Fig. 31, Pl. XVIII):

| | |
|---|---|
| Antero-posteriorly . . . . | 26 mm. |
| Dorso-ventrally . . . . | 13 mm. |
| From side to side . . . . | 10 mm. |

*Localities.*—The Knowles or Winghay Ironstone of North Staffordshire.

*Observations.*—This is an interesting species, making as it does by its external appearance a link between Naiadites and Anthracomya, *Naiadites elongata* very closely resembling *Anthracomya minima*. The resemblance is so close that it is impossible to separate imperfect examples; and it has occurred to me that this may be an example of protective mimicry rather than an actual closer connection between the two genera. The examples of *N. elongata* which have occurred to me nearly all possess the shell well preserved, and therefore the characteristic anterior triple muscular scars are not available for generic determination, but I have satisfied myself that they are present.

The umbones, too, have the distinctive appearance which obtains in Naiadites; but, being small and inconspicuous, are often not well freed from their matrix, which as far as I can find at present is always ironstone, and on this account very difficult to remove. Another distinctive feature which may be relied upon to distinguish Naiadites from Anthracomya is the inequality of the valves in the former. This is always present, though less marked in this species than in others. The absence or presence of a byssal notch is another important distinction, being always present in Naiadites. From a study of a series I have come to the conclusion that when young the shape of the shell

differs much from that which subsequently the full-grown specimen assumes, being much more oblique, and having the posterior end much more expanded comparatively to the rest of the shell. (Pl. XVIII, figs. 34 and 35.)

6. Naiadites obesa, *R. Etheridge, jun.*, 1878. Plate XIX, figs. 1—16.

| | | |
|---|---|---|
| | Anthracoptera ? obesa, *R. Etheridge, jun.* | Quart. Journ. Geol. Soc., vol. xxxiv, pp. 12, 13, pl. i, figs. 12, 13 (and 14 ?), 1878. |
| | Anthracoptera tumida, *R. Etheridge, jun.* | Memoirs of the Geol. Surv. Scotland, Expl. of Sheet 31, p. 82, 1879. |
| | Myalina modioliformis, *Kirkby.* | Quart. Journ. Geol. Soc., vol. xxxvi, p. 585, 1880. |
| | Anthracoptera obesa, *Hind.* | Ibid., vol. xlix, p. 255, 1893. |
| | — tumida (pars), *Hind.* | Ibid., vol. xlix, p. 255, 1893. |
| Non | — — — | Ibid., vol. xlix, p. 255, pl. vii, figs. 13, 14. |

*Specific Characters.*—Shell tumid, transversely triangular, with a strong diagonal blunted gibbosity or ridge dividing the valves into two nearly equal diagonal halves, more pronounced in the left valve. The anterior end is tumid but small, obtusely pointed, marked off by a very shallow and oblique constriction anterior to and parallel to the ridge. The anterior border is bluntly curved, pointed above, soon sloping downwards and backwards, so that it passes gradually into the inferior border, which in front is oblique but straight, posteriorly is bluntly rounded or even angulated. The byssal notch, most marked in the left valve, is situated just anterior to the point where the oblique swelling becomes marginal. The posterior end is obliquely truncated from above downwards and backwards, making above an obtuse angle with the posterior end of the hinge-line, below becoming rounded off into the lower border.

The hinge-line is straight, somewhat less than the greatest antero-posterior length of the shell. The umbones are obtuse, delicately pointed at tip, which is situated at a point distant from the anterior extremity of the hinge-line equal to one tenth of the length of that line, not contiguous, raised above the hinge-line. Umbonal swelling is not marked off from the gibbose anterior part of the shell, posteriorly it is continuous with the oblique diagonal ridge, which is very marked in its upper two thirds and best defined on its anterior side; posterior to the ridge the shell becomes gradually compressed, more especially upwards where the posterior slope is convex. The ridge is almost median, but really slightly anterior to the true diagonal of the shell.

*Interior.*—Anteriorly there are only two muscle-pits, but the lower is very large, and probably represents the two lower scars of other species. The upper or smaller scar is in its proper situation. The posterior adductor muscle scar has not been noted. The pallial line is represented by a series of small pits.

The hinge-plate is striated longitudinally, broad in front, becoming gradually narrow behind. In front the lower edge is thickened and projects as a cardinal tooth, that of the left valve being anterior and above. The anterior edge of the shell is thickened and bevelled at the expense of its outer surface, exposing the layers of shell-matter.

*Exterior.*—The surface is ornamented with lines of growth, which, crowded in front, soon separate and become parallel to the margins.

*Dimensions.*—Pl. XIX, fig. 16, measures:

| | |
|---|---|
| Antero-posteriorly . . . . | 34 mm. |
| Dorso-ventrally . . . . | 25 mm. |

*Localities.*—Scotland:—Micaceous sandstone, Drumsheugh. Water-of-Leith and Dean Bridge, Edinburgh, in the Wardie Shale group of the Cement-stone series. Corstorphine Hill (shale), in limestone above the sandstone of Craigleith quarry, Edinburgh. Shale above the "Brownstone" portion of the Boness lower ironstone Edge-coal series, Duncan pit. Shingle pit and Cowsie mine, Boness. Zone 6, 40 feet below the Encrinite bed, east of Pittenweem. Zone 11, east of Target, Billowness. Zone 13, below sandstone at Billowness. Zone 14 and 15, east of Billowness. Anstruther Wester, zone 17. Zone 18, west of Dreel Burn. In ferruginous sandstone, opposite Kilrenny mill. Limestone Nos. 2 and 3, Randerstone, east of Kingsbarns' Harbour. Above the bed of coal at the Rock and Spindle, near St. Andrews, all in the Calciferous sandstone series of the Fifeshire coast.

*Observations.*—This form is sufficiently different from others to merit a specific name, and it appears to be confined to the Lower Carboniferous beds, occurring in the Calciferous-sandstone series and Middle Limestone series of Scotland, and is therefore the earliest known form of this genus in Carboniferous beds. *Naiadites obesa* was evidently gregarious. There are beds on the Fifeshire coast, of one or two feet in thickness, composed of masses of this shell, which extend for a considerable distance. After much laborious field-work, Mr. James W. Kirkby has been able to gather, from portions of such beds which have become decomposed by the action of air and sea-water, several fragments from which the internal anatomy of the shell has been made out, so that the characters of this, the earliest known form, are known even better than the more recent.

Mr. Kirkby at first gave the MS. name of *Myalina communis* to this shell, but subsequently, in his paper (*op. supra cit.*) he doubtfully referred it to *Modiola modioliformis*, Brown, 'Foss. Conch.,' pl. lxvi, fig. 19. This, however, Mr. R.

Etheridge, jun., pointed out to be probably a dwarfed form of *Myalina crassa*, Fleming, a conclusion which I think to be probably correct. *Naiadites obesa*, Etheridge, and *Naiadites crassa*, var. *modioliformis*, have really little in common, and Mr. Etheridge does not, in his observation on the new species, mention any connection between them.

I made a visit to the Fifeshire coast to obtain specimens, and Mr. Kirkby generously placed all his material in my hands, so that I have been able to examine a large number of specimens which I have compared with the originals of the figures of Mr. Etheridge's *Anthracoptera obesa*, in the Museum of Science and Art, Edinburgh, and with a series of eleven specimens from Boness, kindly lent to me from the Geological Survey Collection of Scotland, which are doubtless the shells which served for Mr. Etheridge's description; and after careful examination I have come to the conclusion that the Calciferous Sandstone shell and the Boness specimens belong to the same species. In the Calciferous Sandstone beds of the Fifeshire coast, Mr. Kirkby has shown that *Naiadites obesa* is found accompanied by several Ostracoda. *Beyrichia subarcuata*, *Carbonia fabulina*, *C. subula*, *C. Rankiniana* or *bairdiodes*, *Leperditia Okeni*: *Cythere*, sp.; *Spirorbis*; Fish (Rhizodus) remains; a small Gasteropod; *Littorina Scotoburdigalensis*, Etheridge, of doubtful genus, *Carbonicola antiqua* (Hind), and plant remains.

In only one case, that of Zone 12 (*op. cit.*, page 568) does Mr. Kirkby find this shell with typical marine forms, Lingula and Schizodus, but this bed of shale is in close contact with a limestone containing the usual fauna and flora which accompany *N. obesa*. No other fossil remains are said to occur with the shells in the Boness beds.

Now that I have been able to see a large number of shells, I find that the specimens which I figured (*op. sup. cit.*) as *Anthracoptera tumida* from North Staffordshire are only very obese forms of *N. carinata* (see p. 140, and Pl. XVIII, figs. 13, 14, and 16). In fact I have not met with this form out of Scotland.

I have little doubt that Mr. Etheridge's two forms are really the same species. It will be noticed in the original paper that he is somewhat in doubt as to the true genus of his shell, and places the mark ? after the generic name. In his observations he points out that his shell closely resembles some forms of Myalina, from which he separates it because he saw no trace of the striated hinge-plate. It is very curious how completely this character is hidden when the fossils are embedded in matrix, or the two valves in proper apposition.

By the kind permission of the Director of the Science and Art Museum, obtained for me by Dr. Traquair, I refigure one of the type specimens, Pl. XIX, fig. 16; but it differs much from the other figures given of the same shell. This is a full-grown and large example, and many shells of the same size occur in the shore beds opposite Kilrenny Mill, Fife, while those like the other type figures are common,

and are evidently younger forms. Mr. Etheridge says: "The much more central position of the diagonal ridge, greater convexity of the shell, and the sigmoidal margin of the posterior end"—the latter character, however, is not shown in the large type-specimen,—"at once distinguish *A. obesa* from" *A. carinata*, *A. quadrata*, and *A. modiolaris*. These shells, however, all at times have a sigmoidal posterior margin, and *A. carinata* is often very much swollen; but I regard the more central position of the diagonal ridge, and its obesity, as characteristic features. It is just these points that Mr. Etheridge also advances as diagnostic of his other species, *Anthracoptera tumida* at p. 82 of the 'Memoirs of the Geological Survey of Scotland,' Explanation of Sheet 31, where he says: "*A. tumida* has for its essential characters the great tumidity of the valves, strong and nearly median diagonal ridge, and prominent beaks." He states, however, further on that "the general outline of *A. tumida* approaches much nearer to another species of the same genus lately described by me, *A.? obesa*, but many of the points already indicated will also serve as distinctive ones in this case." On carefully comparing both descriptions, there is no real point of distinction offered, and I cannot but think that both *A. obesa* and *A. tumida* belong to the same species, which therefore retains the name of *obesa*. The shells from Boness in the Survey Collection are all more or less crushed and pressed out of shape. I figure three of the most perfect, Pl. XIX, figs. 12—14. At page 80 I pointed out that I suspected the identity of the shell from the Kilrenny Mill beds with Mr. R. Etheridge's *A.? obesa*, but at that time I had not satisfied myself that an anterior hinge-tooth was present in the genus Naiadites; in fact it was the presence of a well-marked tooth in the form that made me search for traces of it in the other species of the genus Naiadites, with the result that I found distinct traces of it in most species.

7. Naiadites crassa (Fleming). Plate XX, figs. 1—11.

Modiolus, sp., *Fleming*. Edin. Phil. Journ., vol. vii, p. 246, pl. ix, fig. 3, 1825.
Mytilus crassus, *Fleming*. British Animals, p. 412, 1828.
Modiola, sp., *Rhind*. Age of the Earth, p. 167, pl. ii, fig. *g*.
Avicula modioliforme (*sic*), *Brown*. Foss. Conch., p. 162, pl. lxvi*, fig. 19, 1849.
Mytilus (myalina) crassus, *King*. Mon. Perm. Foss. Eng., Palæontograph. Soc., p. 159 (no description), 1850.
— crassus, *Morris*. Cat. Brit. Foss., 2nd edit., p. 214, 1854.
Avicula modioliformis, *Morris*. Ibid., 2nd edit., p. 162, 1854.
— — *Salter*. Memoirs Geol. Surv. Scotland, No. 32, p. 146, 1861.
Myalina crassa, *Huxley and Etheridge*. Cat. Foss. Mus. Pract. Geol., p. 110, 1865.

MYALINA CRASSA, *R. Etheridge, jun.* "On Carboniferous Lamellibranchiata," Ann. Mag. Nat. Hist., ser. 4, vol. xv, p. 427, pl. xx, figs. 1—5, 1875.

— — var. MODIOLIFORMIS, *R. Etheridge, jun.* "Invertebrate Fauna of Lower Carb.," Quart. Journ. Geol. Soc., vol. xxxiv, pp. 13, 14, 1878.

— — *R. Etheridge.* Foss. Brit. Palæoz., p. 286, 1888.

ANTHRACOPTERA CRASSA, *Hind.* Geol. Mag., dec. 3, vol. x, p. 514, 1893.

*Specific Characters.*—Shell transversely produced, large, triangular, massive. The anterior end is swollen, for the greater part solid, acutely pointed above, forming a small lobe in front of the beaks. The anterior border very thin, and showing layers of shell above, slopes rapidly downwards and backwards, being only slightly convex at first; the edge of the shell then becomes thin and sinuous, in the centre of which is the byssal notch, much more pronounced in the left valve. From the byssal notch the lower border is almost straight, but still directed obliquely downwards and backwards. The posterior end includes the greater portion of the shell, and has a truncate posterior border very slightly obliquely cut from above downwards and backwards; it joins the inferior side by a bluntly rounded curve, and above forms an obtuse angle with the posterior end of the hinge-line, which is straight, only very slightly shorter than the extreme length of the shell. The umbones are anterior, not quite terminal, small, and pointed, very slightly elevated above the hinge-line; in unworn specimens a little incurved at the apices so as to project over the hinge-line. From the umbones a well-developed oblique gibbosity, more conspicuous in the left valve, extends across the shell downwards and backwards towards the inferior border, which it reaches some distance in front of the posterior inferior angle of the shell. Anterior to this swelling the shell is much constricted, the left valve being the more so. This constriction becomes broader and shallower as it approaches the edge of the shell, where it corresponds to the sinuosity of the margin and the byssal sinus. Posteriorly the oblique gibbosity becomes compressed, especially upwards into the hinge-line, so that the shell becomes flat towards the posterior end, and the valves must here be almost in contact.

*Interior.*—The anterior adductor impressions are double, often triple, pit-like. When triple, the middle scar is the largest. The posterior adductor scar is large, shallow, very delicately ribbed, situated on the posterior slope some little distance within the margin of the shell. The marks for the insertion of the byssal muscles are seen just below the hinge-line. The inner surface of the shell is smooth. Its pallial line is some little distance within the valves, marked by a row of pits which in some specimens have coalesced into a continuous line.

The hinge-plate is elongated, broad in front, becoming narrow behind, very

slightly bevelled at the expense of its upper edge; longitudinally striated, in old specimens as many as fifteen striæ; these, thickened and less defined, are continued round to the thickened, anterior border. In front the lower edge of the hinge-plate is thickened forming an ill-defined tooth, that of the left valve being anterior to that tooth in the right.

The shell substance is very thick, and in front encroaches much on the cavity for the animal. Posteriorly it becomes much thinner, and is rarely preserved. The apex of the cavity of the shell does not at all correspond with the exterior, being below and behind the real anterior point of the shell.

*Surface* ornamented in a similar way to that of other members of the genus.

*Dimensions.*—Pl. XX, fig. 10, a cast of the interior, from Beith, measures:

| | |
|---|---|
| Extreme antero-posterior diameter . . | 76 mm. |
| Greatest dorso-ventral (posterior end) . . | 48 mm. |
| From side to side . . . . | 30 mm. |

*Localities.*—Scotland:—Cult's Limeworks near Pitlessie, Fife, in bed of shale over the Mountain-Limestone. Lugton Water, near Dunlop, Ayrshire; Lower Carboniferous Limestone, Woodhall; Water of Leith. Roughwood and Lyon-shields, Beith, in a shale below the Main Post of the Lower Limestone Series.

*Observations.*—I have already referred to the reasons why I have placed this shell in the genus Naiadites, and have discussed the question of its habitat. *Naiadites crassa* has been known to palæontologists since 1825, but has only been figured by Dr. Rhind and Mr. R. Etheridge, jun. I fancy that the former has figured the smaller or dwarfed form (from the Water-of-Leith), noticed at p. 150. Mr. Etheridge's figures and description are very good and typical. In his observations, however, he quotes M'Coy's opinion as to the third or uppermost of the anterior adductor scars being for the insertion of the adductor of the opposite valve. He states too: "immediately in front and within the angle formed by the hinge-plate and the anterior margin is another shallower depression, from which a depressed and more or less interrupted line runs in many specimens across the cartilage area, sometimes even interrupting the furrows themselves." He suggests that the rim or margin, described above, represents the rostral plate of Myalina and Dreissenia. This line and depression are very often absent, and I am inclined to attribute the presence of them to accidents of growth and environment.

The only member of the genus Naiadites which attains anything like the size of *N. crassa* is *N. magna*, but they are very dissimilar, and occur at very different horizons, though both forms have as yet been found only in Scotland.

It is curious to note how very many specimens of this shell obtained from the Cults beds have been damaged and repaired during life. This mussel-bed must have occupied a very exposed position, perhaps off some headland, where they were at the mercy of a strong tidal wave; and in this bed it is very rare to find

the two valves of any specimen in apposition, which seems to point to the fact that this exposure to violence, after the death of the mollusc, caused a separation of the two valves of the shell. The beds at Beith seem to have been subjected to violence, few perfect specimens being found there, though this locality has furnished the bivalve examples figured on Pl. XX, figs. 9 and 10.

A slighter form of this shell, found in several localities, was mentioned by Mr. R. Etheridge, jun., in his paper "On our Present Knowledge of the Invertebrate Fauna of the Lower Carboniferous or Calciferous Sandstone Series of the Edinburgh neighbourhood, especially of that division known as the Wardie Shales, and on the first appearance of certain Species in these Beds" ('Quart. Journ. Geol. Soc.,' vol. xxxiv, p. 13, 1878; read November 7th, 1877), under the term *Myalina crassa* var. *modioliformis*, pointing out that it had been described and figured by Captain Thomas Brown; and I take the figure by Dr. Rhind ('Age of the Earth,' pl. ii, fig. *g*), the original of which is said to have come from Woodhall, Water-of-Leith, to refer to the same form. Indeed, it is very probable that Captain Brown reproduced Dr. Rhind's figure, the two being exactly similar. Mr. Etheridge says: "As I cannot distinguish any characters, either external or internal, by which to specifically distinguish Captain Brown's shell from Dr. Fleming's, I propose to adopt the name given by the former as a varietal designation for the thinner and lighter form of *Myalina crassa*." I have not thought it necessary to preserve the varietal name, agreeing as I do with the observation of Mr. Etheridge that the only difference to be observed is one dependent on environment. The shells from the neighbourhood of Edinburgh are undoubtedly of much slighter build and somewhat undersized, and they are said to occur with *Schizodus Salteri* above and below a marine shale.

This stratigraphical arrangement points to changes of conditions which were doubtless inimical to the robust growth of the shell, and I find that, judging from the specimens I have seen, the shells of Schizodus are also somewhat dwarfed. The beds may have occupied a position near the mouth of a great river, where the volume of fresh water laden with mud proved hostile to the Mollusca which lived in or just beyond the estuary. It should, however, be noted that these slighter forms are the older in point of age, the Calciferous-Sandstone Series being older than the Carboniferous-Limestone beds of Cults and Beith, and that these forms are really the ancestors of those which, under a series of more favourable conditions, grew so luxuriantly at the two localities just mentioned.

8. NAIADITES MAGNA, sp. nov., *Hind.* Plate XIX, figs. 17—20.

*Specific Characters.*—Shell moderately large, globosely subtriangular. The anterior end is somewhat compressed and almost obsolete, and has the same characters which obtain in other members of this genus. The anterior border is convex, meeting the superior border at an angle which is almost a right angle; below it is produced downwards, joining insensibly the inferior border, which has a downward and posterior direction, sinuated in front and pierced for the byssus. Towards the posterior end the inferior border becomes deflected to the left, forming a shallow depression with the concavity looking towards the right, returning to the middle line at the posterior inferior angle, which is blunt and often the situation of a triple S-shaped folding, the sulci of which are to be traced upwards on the body of the posterior and lower part of the shell. The posterior border is truncate from above downwards and backwards, making an obtuse angle above with the superior border, and below is bluntly rounded in direction but folded. The hinge-line is straight, and extends the whole length of the superior border. The umbones are obtuse and swollen, at first directed inwards to the middle line, but before they reach it are bent sharply on themselves forwards, where they terminate on either side of the anterior superior angle; widely separated in casts, and only slightly raised above the hinge-line. From the umbones a very gibbose and broad oblique swelling, bounded in front by an almost obsolete oblique depression, passes downwards and backwards, becoming broader as it nears the margin, near which it becomes broken up into two or more ridges with intervening depressions, the ridges in the left valve being anterior to those in the right and opposite the depressions on the right valve. Above the oblique swelling the shell is rapidly compressed and expanded upwards into the posterior part of the hinge-line, so that the posterior slope of the shell is concave. The greatest convexity of the shell is only slightly below the hinge-line. The inequality of the valves is not so marked as in other species of this genus.

*The interior* has a normal arrangement. Pallial line pitted, entire, and remote from the edge of the shell. The anterior muscular impressions are trifid, the most anterior being the largest. The position of the posterior adductor muscle has not been exposed. There is a shallow groove on each side of the median line, becoming deeper and broader posteriorly for the thickened lower margin of the hinge.

*Exterior.*—The surface is almost smooth, and covered with fine striæ and lines of growth; near the margin the lines of growth are closer, rougher, and more distinct.

*Dimensions :*

| | Antero-posteriorly. | Dorso-ventrally (greatest length). | From side to side. |
|---|---|---|---|
| Pl. XIX, fig. 20, measures | 50 mm. | 35 mm. | 30 mm. |
| Pl. XIX, fig. 19, ,, . | 45 mm. | 30 mm. | 23 mm. |

*Locality.*—Scotland :—Black Band Ironstone, Bankend, Lesmahagow.

*Observations.*—I am indebted to Dr J. S. Hunter, of Braidwood, for the loan of and permission to describe and figure these specimens, which are second in size only to *N. crassa* of the Carboniferous Limestone. These shells can be distinguished from all others by the alternate fluting of the valves at the posterior inferior angle, a character which is not very apparent in young specimens (Pl. XIX, figs. 17 and 19), but becomes more developed with age.

The shape and general appearance of the shell at first suggested a reference to Mr. Etheridge's *Anthracoptera obesa*, but from this form *N. magna* is distinguished by its more obtuse gibbosity, not so nearly central, and the folding of the posterior inferior angle of the shell, a character I have observed in no other species of this genus.

Mr. Etheridge says that the posterior margin of his shell is sigmoidal, and this is shown only in one of his figures ; but this curve refers to the margin only, and must not be thought to apply to the peculiar crumpling of the posterior inferior angle of *N. magna*, a character which is shown to be absent in all figures of *N. obesa*.

*N. magna* occurs at a much higher horizon than *N. obesa*, having been obtained up to the present time only from the Blackband ironstone, placed, in the 'Geological Survey Memoirs,' Explanation of Sheet 23, p. 80, at the base of the middle beds of the Carboniferous Limestone Series. Judging from the Bankend section given at p. 32 of the same memoir, there is only one Blackband ironstone, the position of which is given about the centre of these middle beds ; and at p. 26 the main Lesmahagow gas coal, which is stated at p. 80 to overlie the Blackband ironstone, is again given as follows :

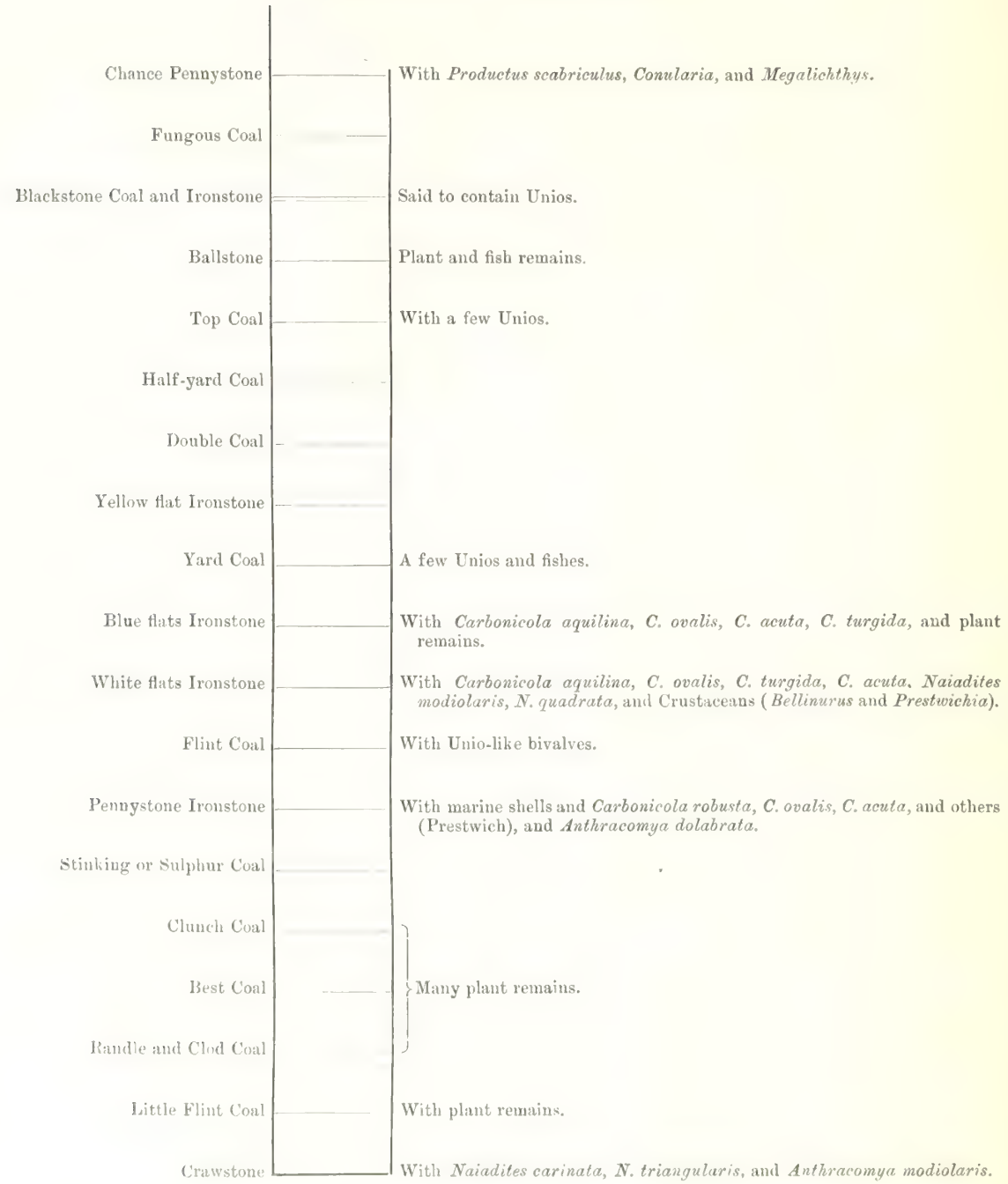
| | | Ft. | Inch. |
|---|---|---|---|
| *Upper Group* | . . . . . | 232, | 5. |
| *Middle Group* | Strata with their coals and clay ironstone . | 188, | 0. |
| | Main Lesmahagow Gas Coal . . | 1, | 10. |
| | Strata . . . . . | 165, | 0. |
| *Lower Group* | . . . . . | 114, | 9. |

## § IV. DISTRIBUTION.

It has been considered advisable, in order to give a graphic idea of the horizontal distribution of the various species of the genera Carbonicola, Anthracomya, and Naiadites, that diagrammatic sections of each of the coal-fields and of other Carboniferous strata in which they occur should be given. I have therefore compiled such a series of stratigraphical tables from actual pit-sections, and also from vertical tables given of the various Coal-fields in the 'Memoirs of the Geological Survey,' and in Professor Hull's 'Coal-fields of Great Britain.' These sections are only intended to show the succession of strata and relative position of the shell-bearing beds in the various districts, and, except where indicated, are not drawn to scale. Wherever the species occurring in any bed are given, I have personally identified them in Collections; and the localities in these lists are therefore more definite and more accurate than those in the text. Of course there are probably many more horizons at which mussel-bands occur, but these have either not been recorded, or no specimen from them has come to hand for identification.

I am specially indebted to Mr. James W. Kirkby and Mr. John Smith for the sections of the Fifeshire and Ayrshire Coal-fields, and to the former also for permission to copy his section of the Calciferous Sandstone Series of Fife. In those cases where no section of a coal-field mentioned in the text is given, the omission is due to the absence of the necessary detailed information.

## 1. Coal-field of Coalbrookdale.




Note.—In Professor Prestwich's monograph the name Unio is given to Carbonicola, Anthracomya, and Sanguinolites, so that it is uncertain, where Unio-like shells are said to occur in a bed without specific name, as to which of these genera they belong. In the list, however, at pp. 491, 492 of his work marine shells are stated to occur only in the Pennystone and Chance Pennystone beds.

## 2. South-Staffordshire Coal-field.

* Shale above the Brooch Coal contains *Carbonicola acuta* and *C. similis.*

Brooch Coal

Brooch Ironstones — *Carbonicola aquilina;* very plentiful.

Pins and Pennyearth Ironstone Measures

Thick Coal

Grains Ironstone — *Carbonicola aquilina, C. nucularis, Anthracomya modiolaris, Naiadites modiolaris, N. carinata,* and *N. triangularis.*

Gubbin Ironstone — *Carbonicola acuta, C. aquilina, Anthracomya turgida, Naiadites modiolaris,* and *N. carinata.*

Table Batt

Heathen Coal

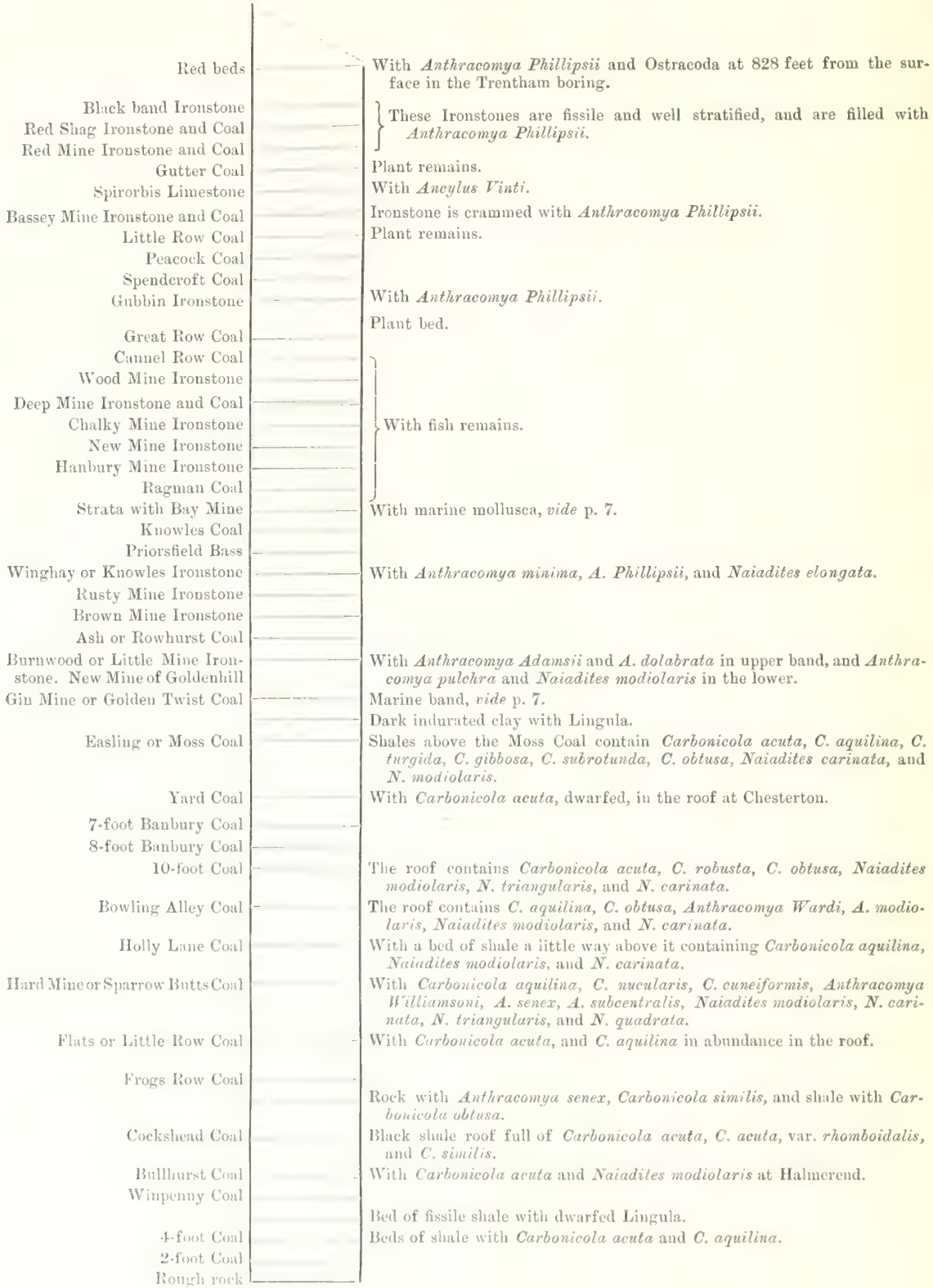
New Mine or Whitestone

Pennystone or Cakes, &c. — "Near Oldbury fossil shells are abundant in the upper part of the cakes and bottom of the Whitestone,—both the shells known formerly as Unio, and now called Cardinia and Anthracosia, and others, such as *Producta, Aviculopecten*. . . . . It is remarkable that the shells called Cardinia are *never*, or very rarely, mingled in the same mass of stone with any of the other shells, except in rare instances with a solitary Lingula" (Beete Jukes, 'Iron Ores of Great Britain,' pt. ii; 'The Iron Ores of the South Staffordshire Coal-field,' pp. 111, 112.

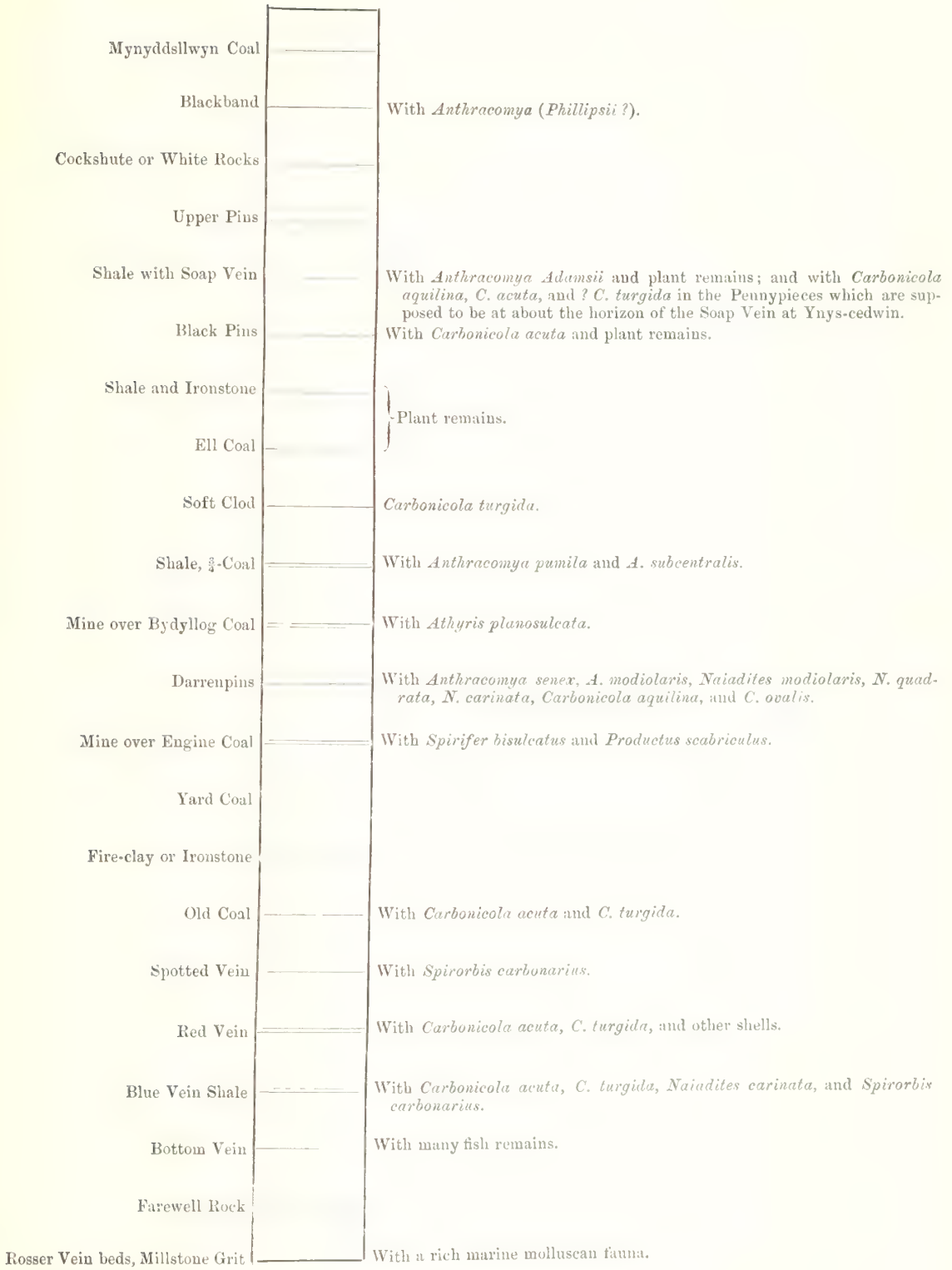
I can find no record of Mollusca from any beds below the Pennystone.

* At the Hamstead Colliery a band of marine fossils was passed through at 60 yards above the Thick Coal. Prof. Hull gives the Brooch Coal as 43 yards above the Thick Coal. This band was said to contain *Anthracosia Urei,* which is probably a mistaken reference.

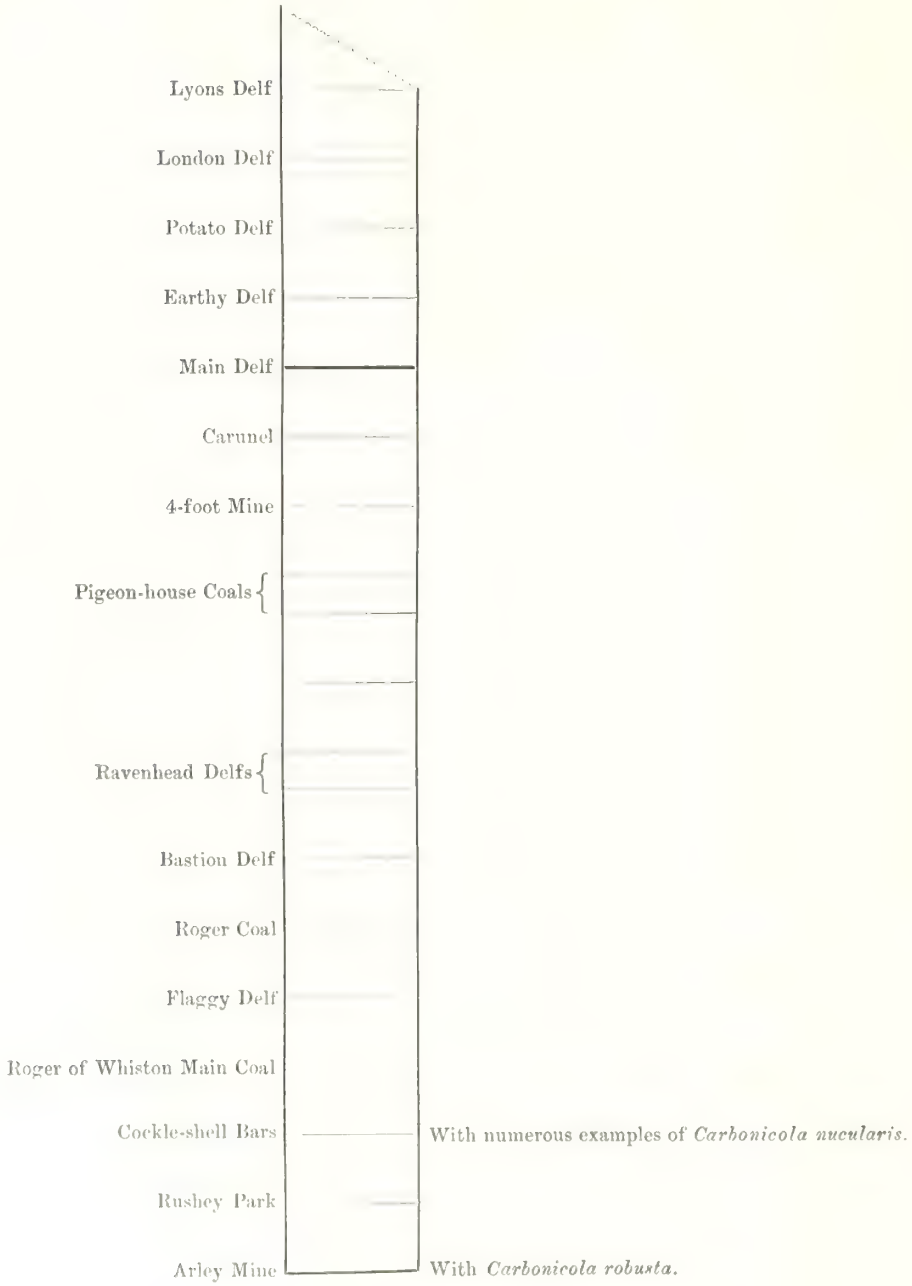
## 3. North Staffordshire Coal-field.



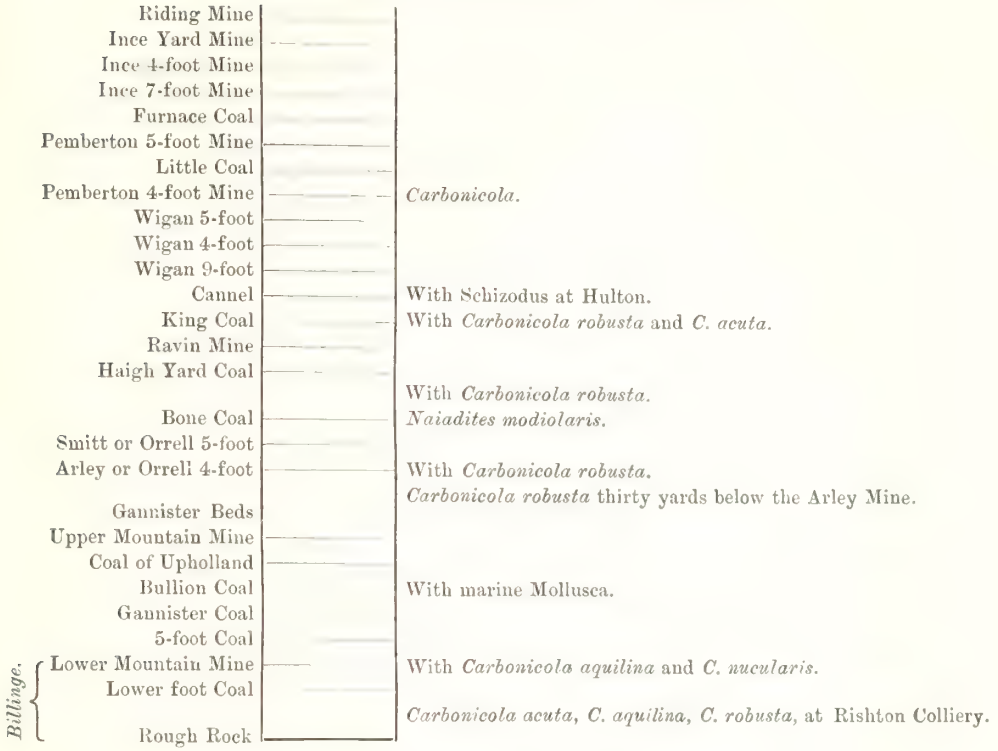
## 4. Coal-field of South Wales.



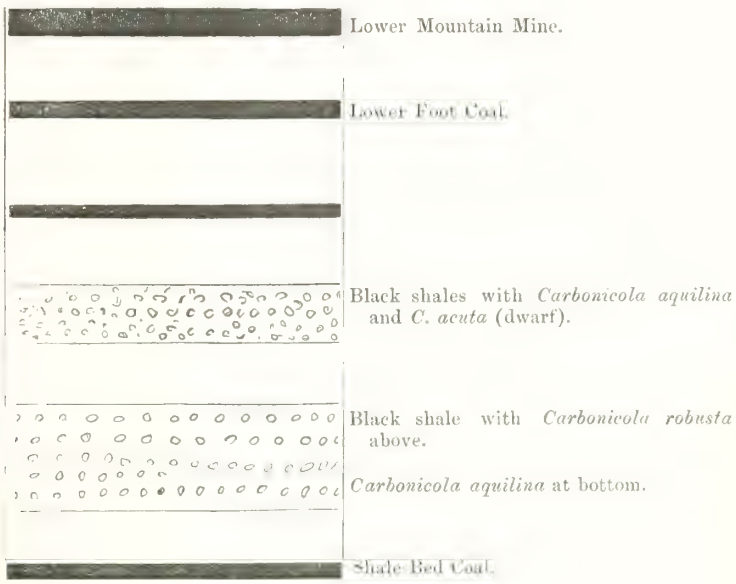
5. West-Lancashire Coal-field—St. Helen's.



### 6. Lancashire Coal-field—Wigan.

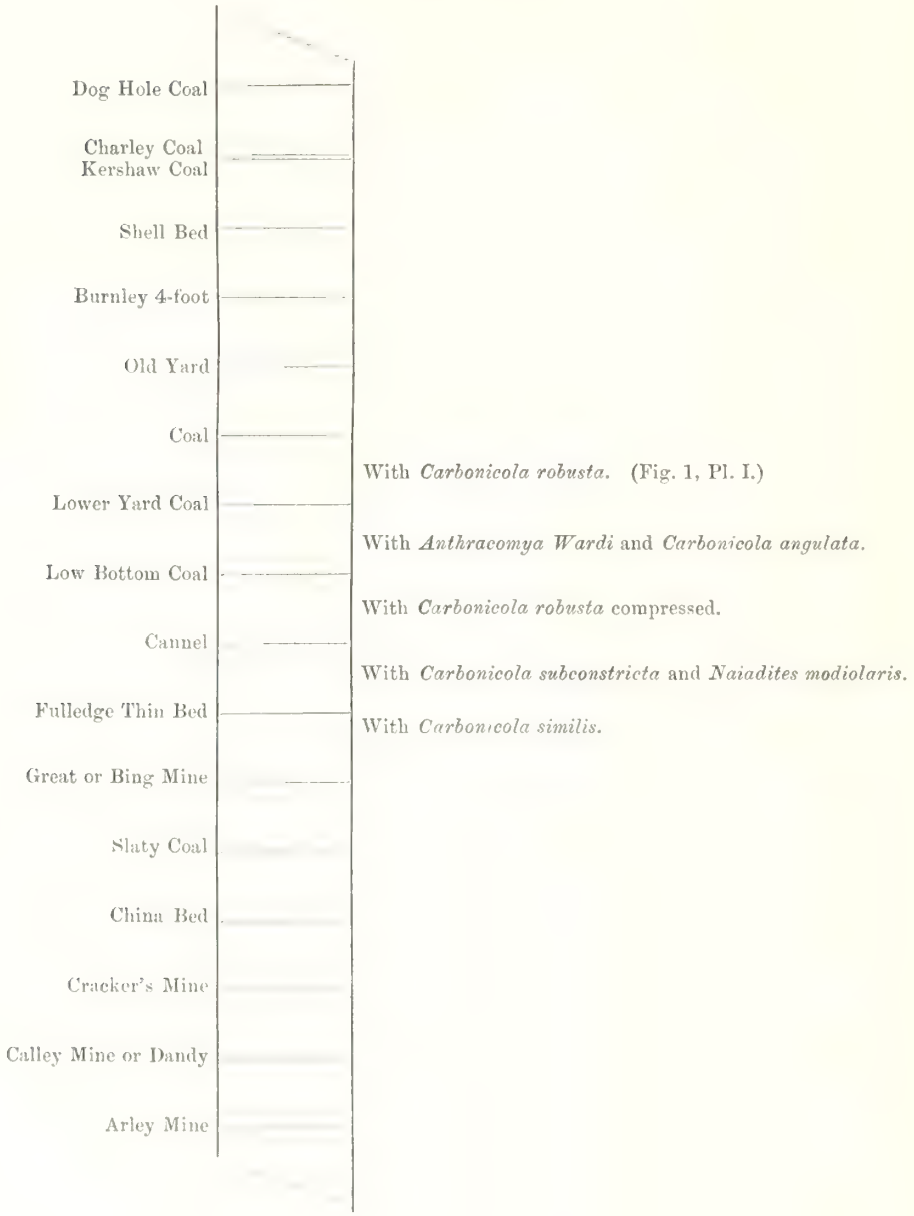



### 7. Detailed Section of Shell-Beds* below the Lower-Mountain Mine of Rushton Colliery, near Blackburn. Furnished by Wm. Pickup, Esq.

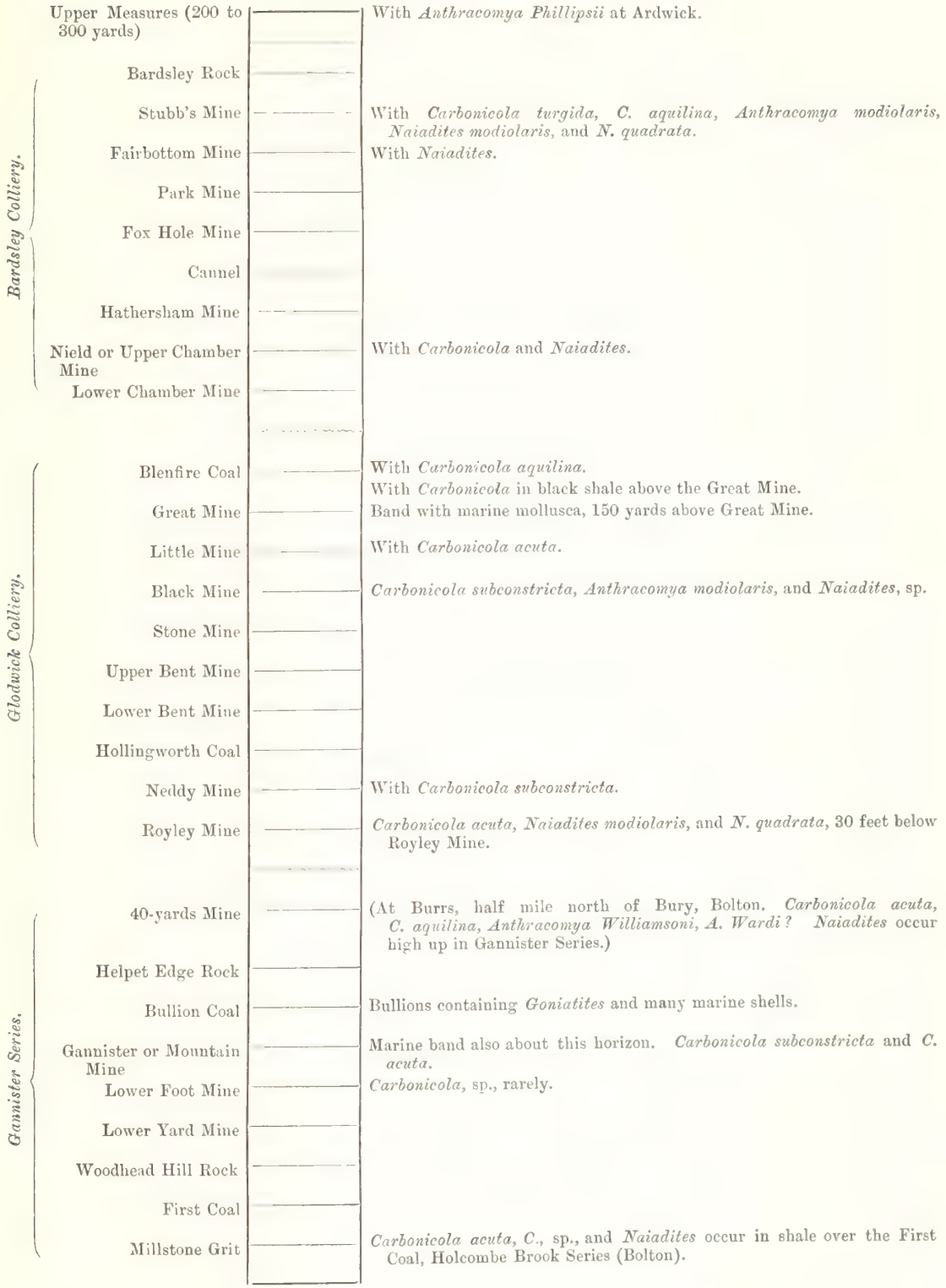



* Of course these beds lie at a considerable inclination to the horizon.

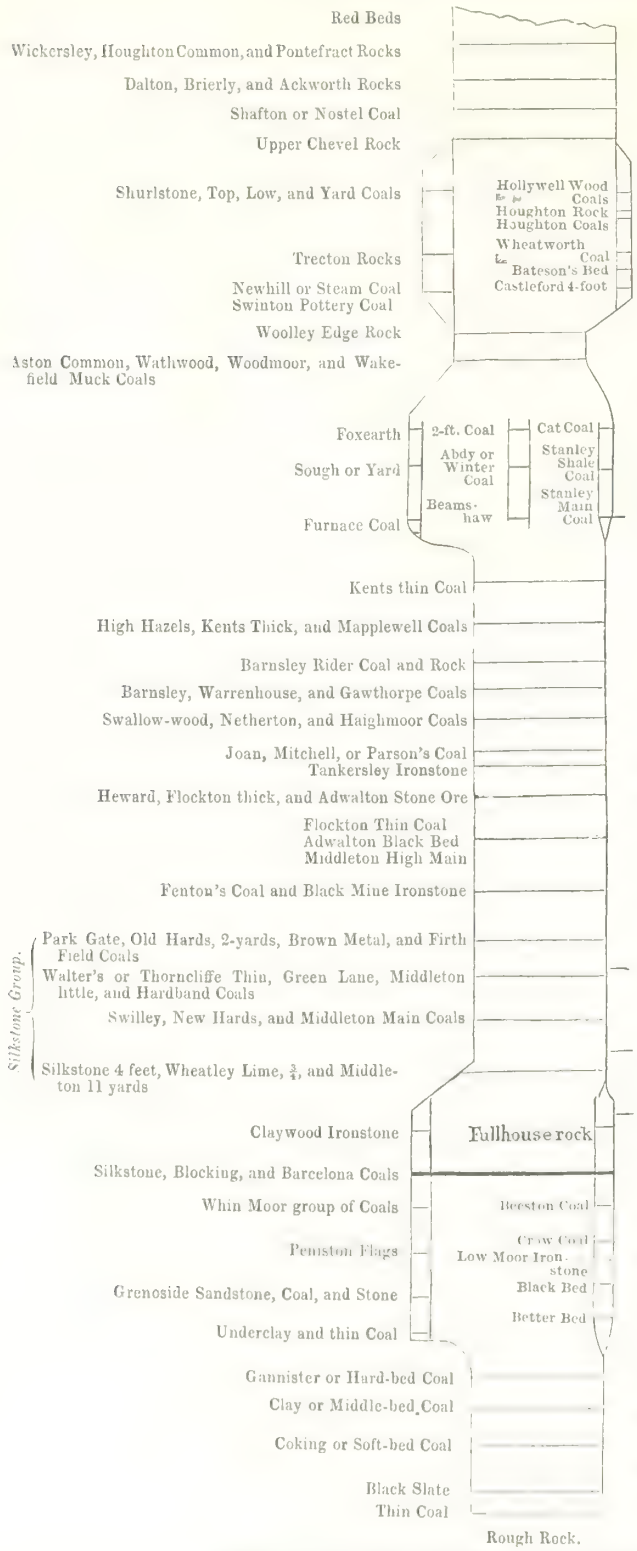
8. Burnley.—Fulledge and Cliviger Sections.



## 9. Lancashire Coal-field—Oldham District.



## 10. Yorkshire Coal-Measures—General Section.

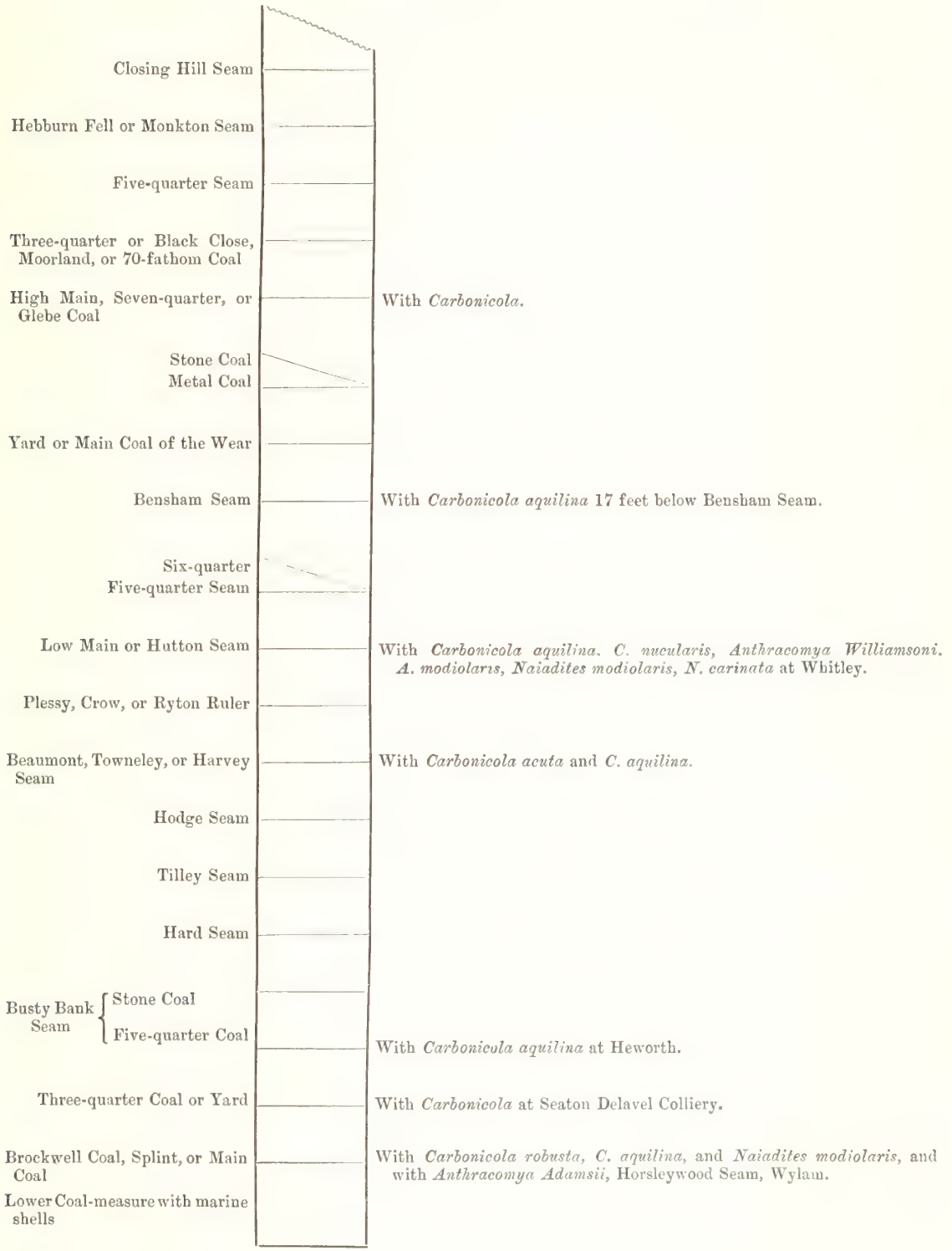



Black shale over the Coal at Beacon Hill, Halifax, contains *C. robusta*, *C. acuta*, and *C. aquilina*.

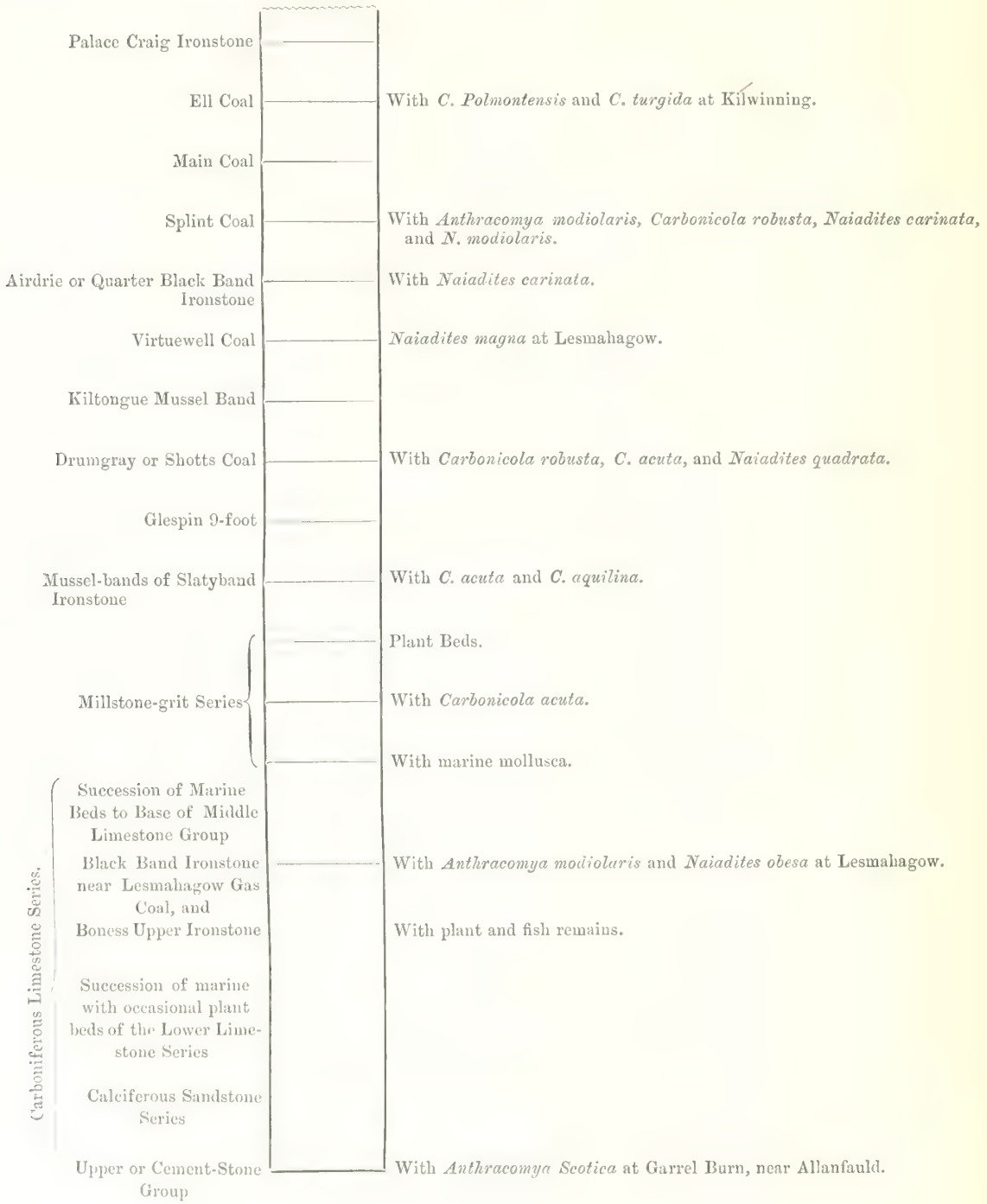
* The numbers refer to pages in the "Geology of the Yorkshire Coal-field," 'Mem. of the Geol. Survey.'

† Probably *C. robusta*, as the Silkstone of Yorkshire is supposed to be the equivalent of the Arley Mine of Lancashire, of which bed this species is typical.

## 11. Northumberland and Durham Coal-field.

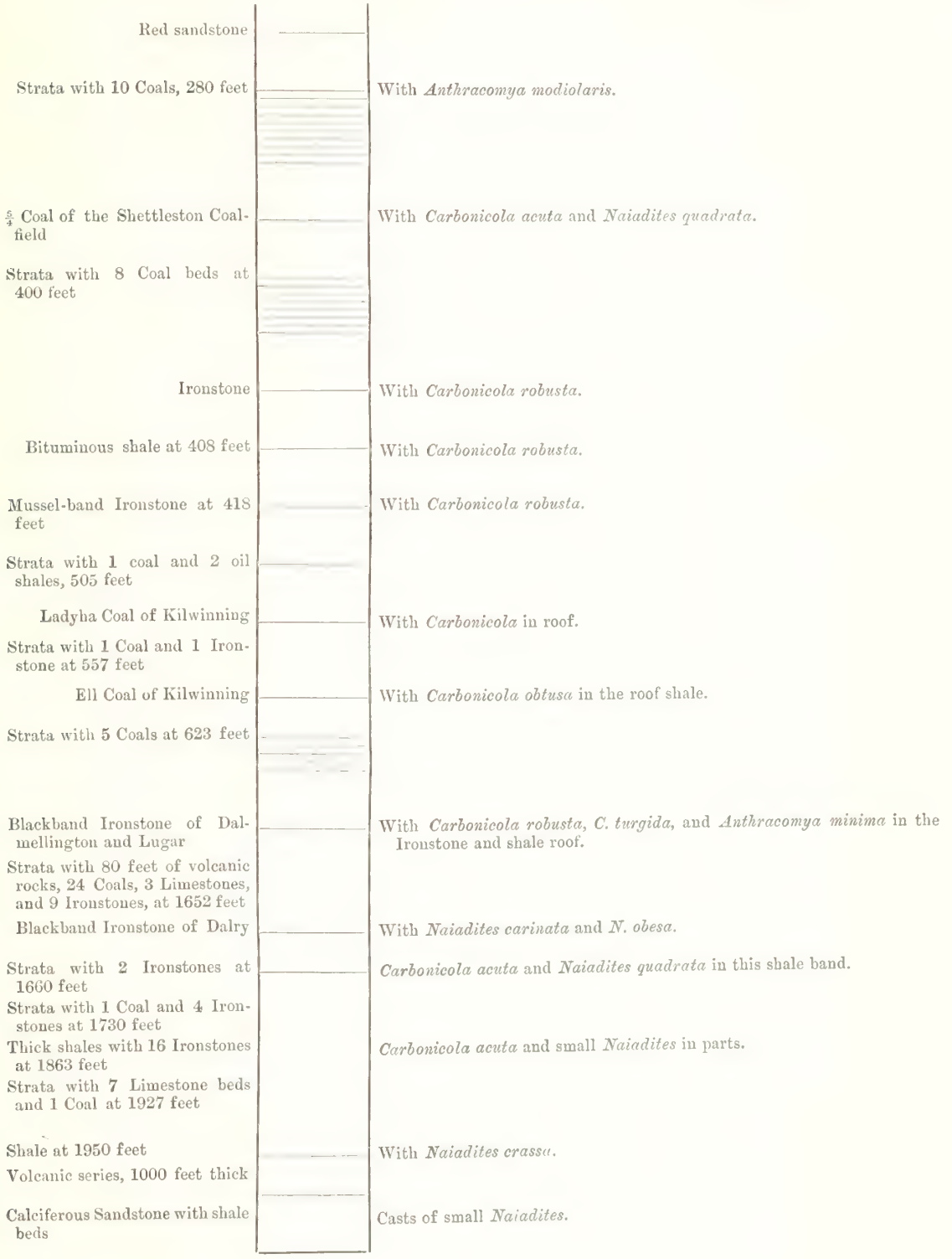


## 12. Succession of Strata—Lanarkshire and West of Scotland.

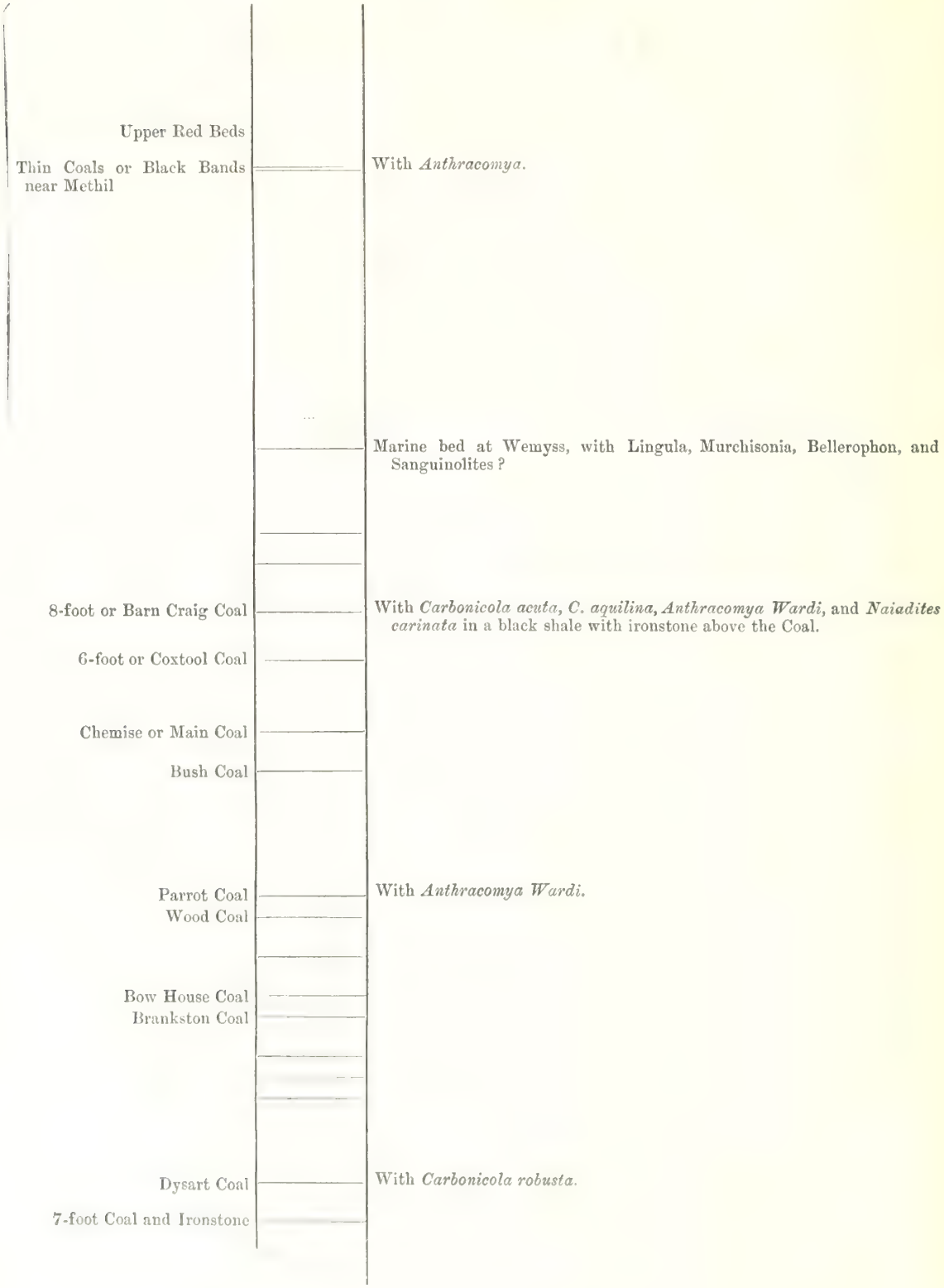


13. Generalised Section of the Ayrshire Coal-field, showing Position of Mussel Bands.

Kindly drawn up for me by Mr. J. Smith, of Kilwinning.

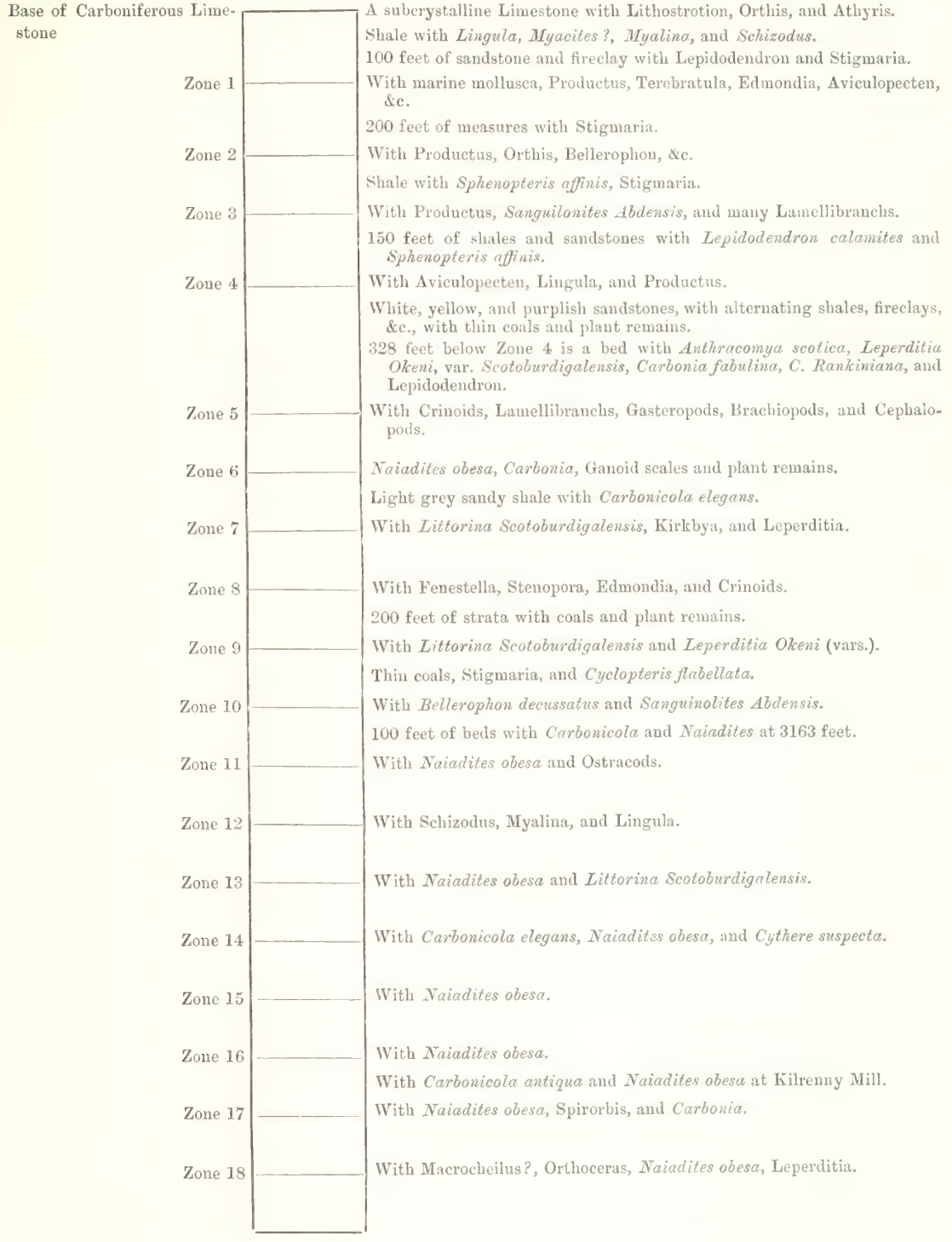


14. Vertical Section of the Fifeshire Coal-Measures (300 feet at the top omitted). Scale, 1 inch to 300 feet. By kind permission of Mr. James W. Kirkby.



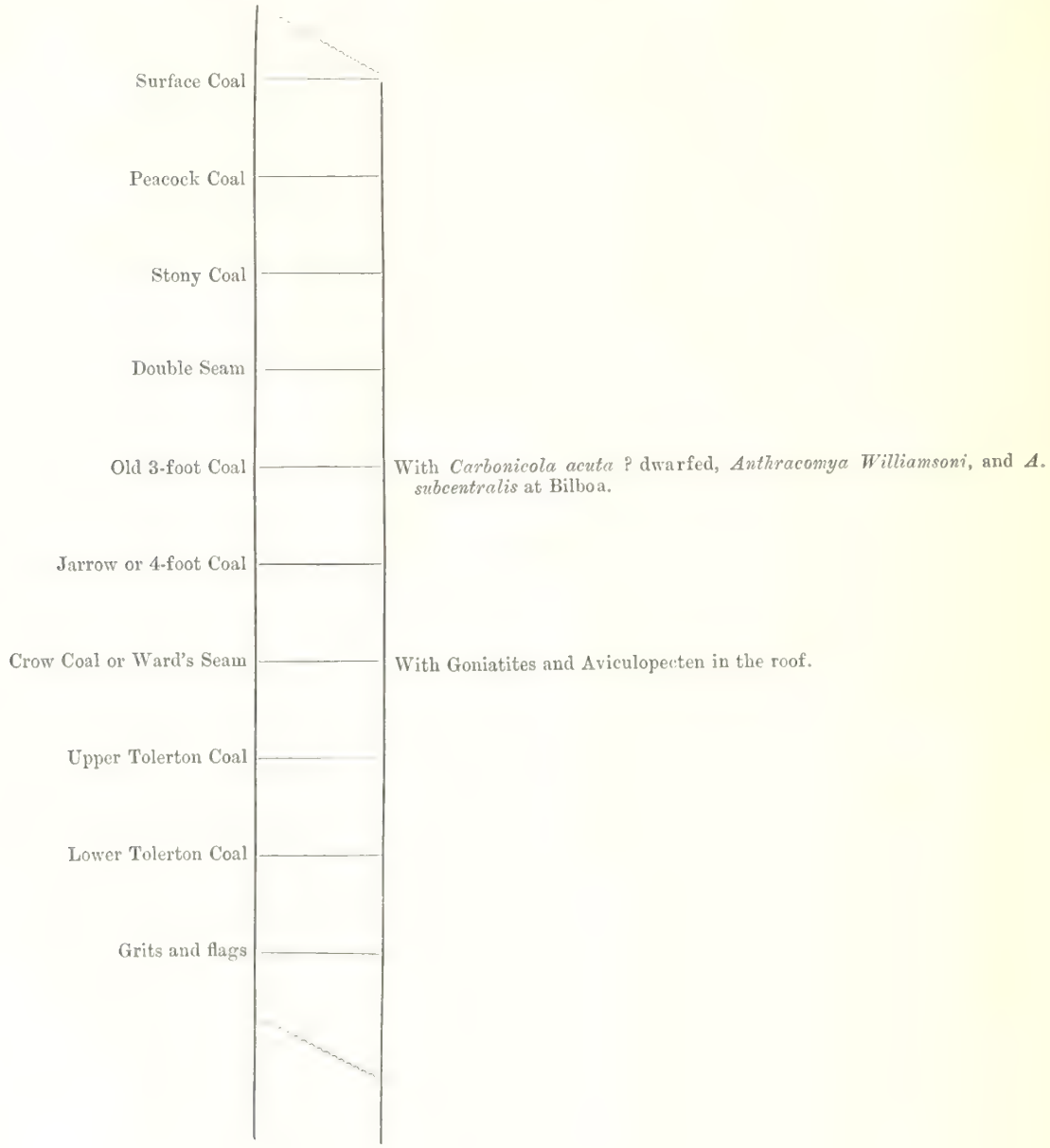
15. Diagrammatic Vertical Section of the Calciferous Sandstone of the Fifeshire Coast. Scale, 666 feet to 1 inch.

By the kind permission of Mr. James W. Kirkby (see also 'Quart. Journ. Geol. Soc.,' vol. xxxvi, 1880, p. 571).

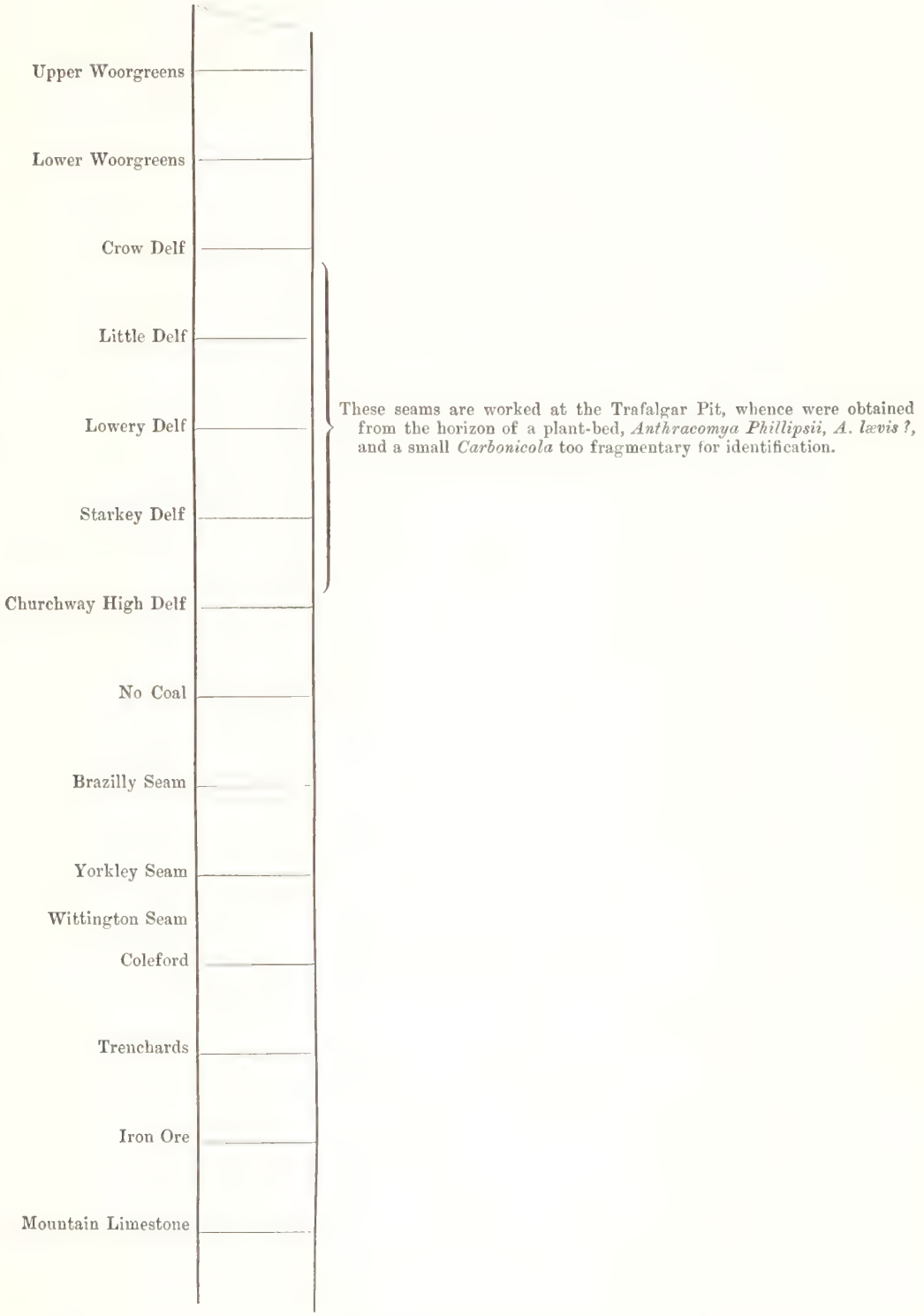



Zones 6 to 18 = zone of *Naiadites obesa*.

16. General Section of the Kilkenny Coal-field at Castlecomer.



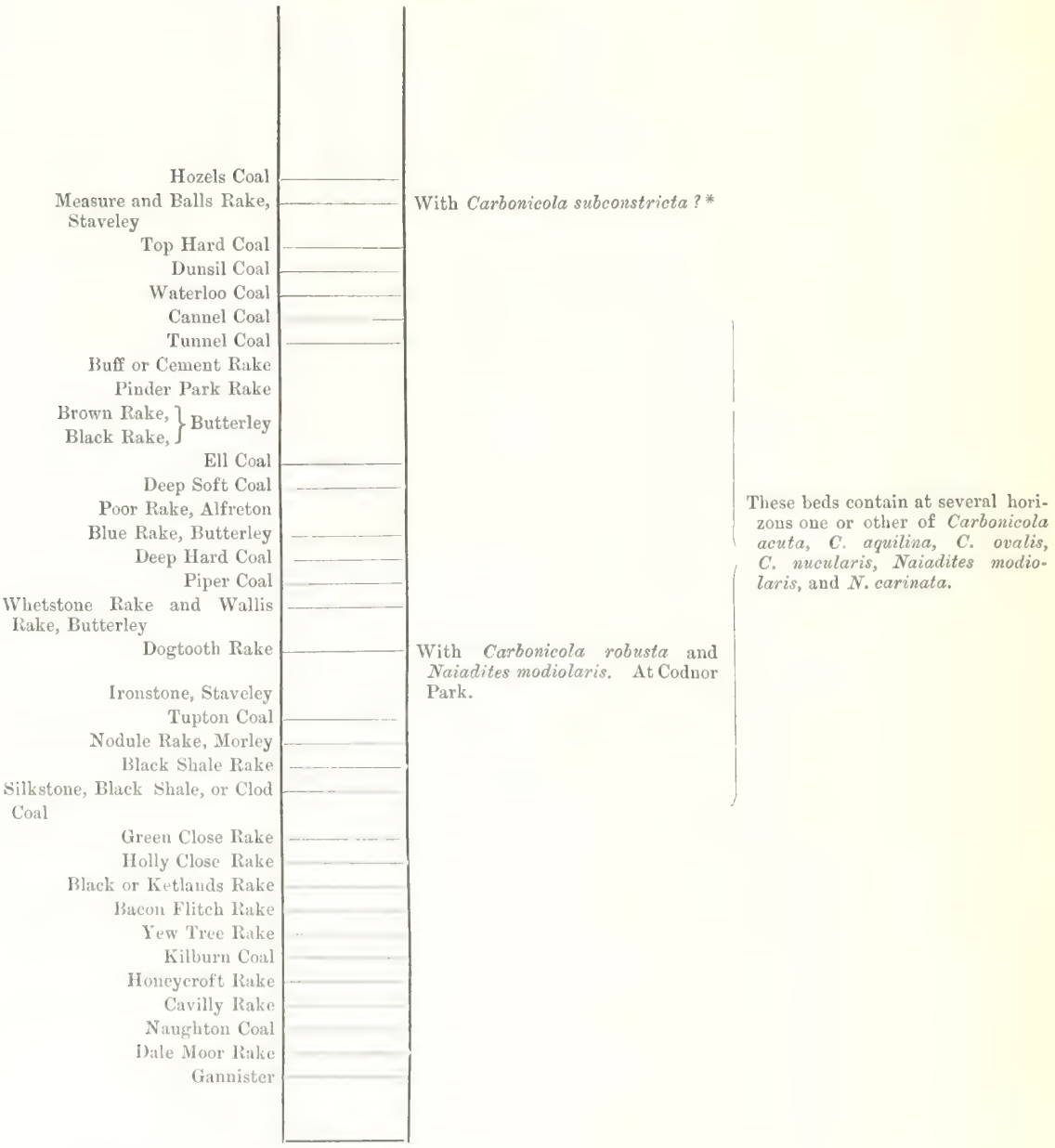
17. Section of the Forest-of-Dean Coal-field.*




* From a paper by Mr. H. D. Hoskold, 'Proc. Cotteswold Nat. Field Club,' vol. x, p. 123, 1891.

## General Section of the Derbyshire Coal-field.

### From Mr. A. H. Stokes' Section.




* In the 'Memoirs of the Geol. Survey of Great Britain,' "The Iron Ores of Great Britain," part i, p. 40, is stated, "This shell, Unio or Anthracosia, probably of several species, is found more or less abundantly in all the Ironstone beds, from the top of the section down to the Black Shale Rake. In the lower measures it is much more scarce, or is even altogether wanting in some of the very lowest. The *Anthracosia bipennis* which occurs in the Measure and Balls Rake is found also in the Low Moor Ironstone, and at Mold in Flintshire."

## PLATE XII.

Figs. 1 and 2.—*Anthracomya Adamsii.* From the Little Mine Ironstone of Great Fenton. My Collection. (Page 89.)

Fig. 3.—*Anthracomya Adamsii.* Right valve showing the straight and narrow hinge-line. Same locality. My Collection. (Page 89.)

Fig. 4.—*Anthracomya Adamsii.* Cast showing muscle-scars and longitudinal grooves on either side of the hinge-line. My Collection. Same locality. (Page 89.)

Figs. 5—9.—*Anthracomya Adamsii.* Same locality. Showing variations in form. My Collection. (Page 89.)

Fig. 9 *a*.—Fig. 9 viewed from above. The umbo is not eroded, but is incomplete. Same locality. My Collection. (Page 89.)

Fig. 10.—*Anthracomya Adamsii.* Showing distinct colour-bands. Same locality. My Collection. (Page 89.)

Fig. 11.—*Anthracomya Adamsii.* Aberrant form. Same locality. My Collection. (Page 89.)

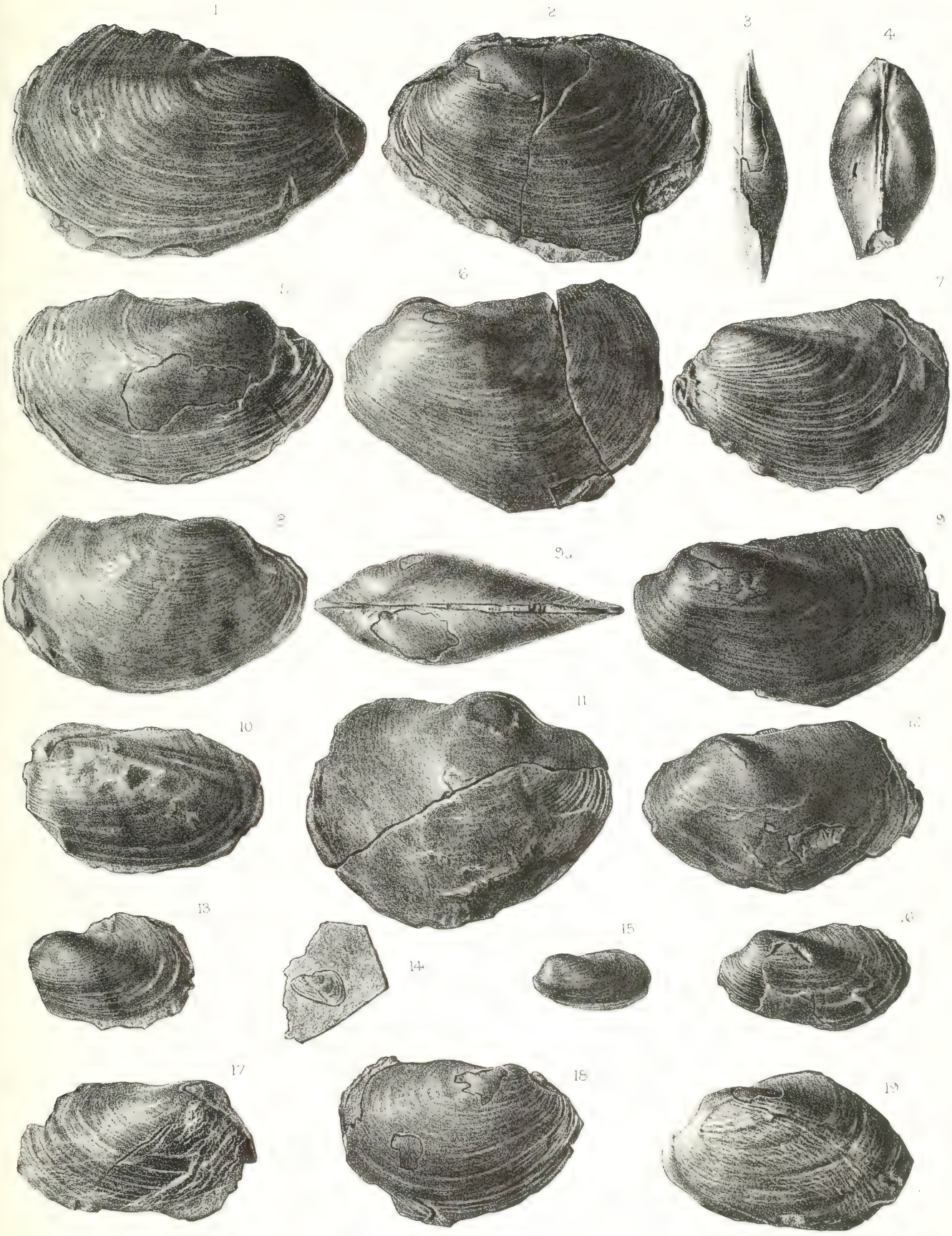
Fig. 12.—*Anthracomya Adamsii.* Same locality. My Collection. (Page 89.)

Figs. 13, 15, 16.—*Anthracomya Adamsii.* Young forms to show stages of growth. Same locality. My Collection. (Page 89.)

Fig. 14.—*Anthracomya Adamsii.* Very young form. Burnwood Ironstone, Newchapel. My Collection. (Page 89.)

Figs. 17, 19.—*Anthracomya Adamsii.* Showing wrinkled periostracum. Little Mine Ironstone, Great Fenton. My Collection. (Page 89.)

Fig. 18.—*Anthracomya Adamsii.* An oval form not full-grown. Same locality. My Collection. (Page 89.)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## PLATE XIII.

Figs. 1—3.—*Anthracomya Adamsii*, var. *expansa*. From the Little Mine Ironstone, Great Fenton. My Collection. (Page 91.)

Fig. 4.—*Anthracomya dolabrata*. The type specimen from Prof. Prestwich's 'Geology of Coalbrookdale,' pl. xxxix, fig. 9, refigured by the Professor's kind permission. (Page 93.)

Figs. 5—9 and 11.—*Anthracomya dolabrata*. A series from the Little Mine Ironstone of Great Fenton. My Collection. (Page 93.)

Fig. 7 *a*.—Fig. 7 seen from above, showing width. (Page 93.)

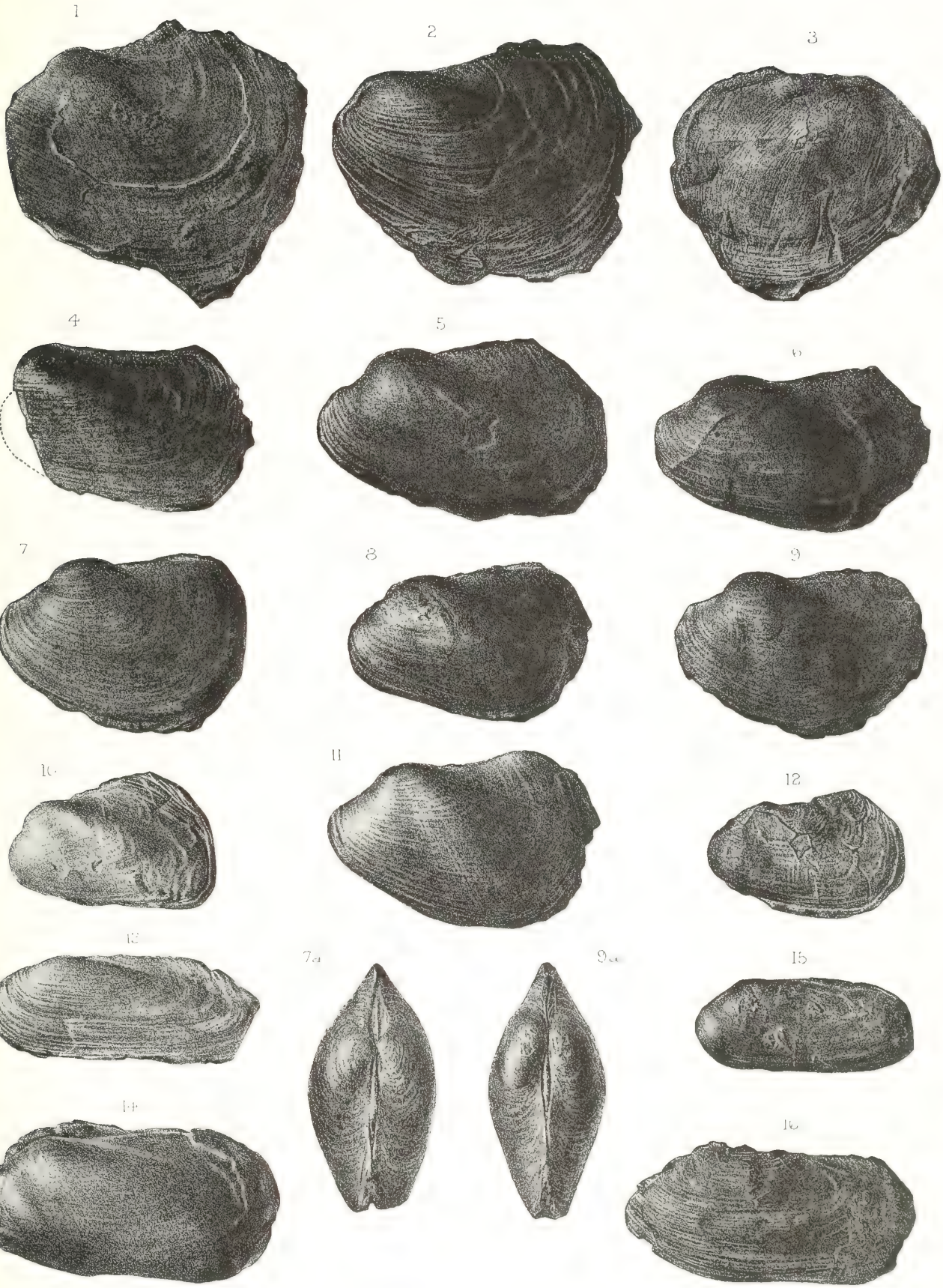
Fig. 9 *a*.—Fig. 9 seen from above. (Page 93.)

Figs. 10 and 12.—*Anthracomya modiolaris*. Short truncate form from the roof of the Holly-Lane Coal, North-Staffordshire Coal-field. In the Collection of Mr. John Ward, F.G.S. (Page 95.)

Figs. 13 and 16.—*Anthracomya Wardi*. Smooth keelless form from the Shale Coal of Wakefield. From the Collection of Mr. David Campbell of Wakefield. (Page 105.)

Fig. 14.—*Anthracomya modiolaris*. The cast of a large form from the Upper Coal-measures of Old Cummock, Ayrshire. From the Collection of Mr. Smith of Kilwinning. (Page 95.)

Fig. 15.—*Anthracomya Wardi*. From the roof of the Eight-foot Coal of Durie, Fife. My Collection. (Page 105.)




de del et lith

Vincent Brooks imp.

## PLATE XIV.

Figs. 1—4.—*Anthracomya modiolaris.* From the roof of the Holly-Lane Coal, Hanley and Bucknall Colliery. My Collection. (Page 95.)

Fig. 5.—*Anthracomya modiolaris.* From the same horizon at Harecastle, North Staffordshire Coal-field. My Collection. (Page 95.)

Fig. 6.—*Anthracomya modiolaris.* From the roof of the Holly-Lane Coal, Bucknall. My Collection. (Page 95.)

Figs. 7 and 8.—*Anthracomya modiolaris.* From the same horizon; Adderley Green. In the Collection of Mr. John Ward, F.G.S., of Longton. (Page 95.)

Fig. 9.—*Anthracomya modiolaris.* A cast. The type specimen figured by Mr. Salter in the Iron-ores of South Wales, pl. ii, fig. 13, refigured by permission of the Director-General of the Geological Survey of Great Britain. In the Collection of the Geological Survey, Jermyn Street, London. (Page 95.)

Fig. 9 *a*.—The same specimen seen from above.

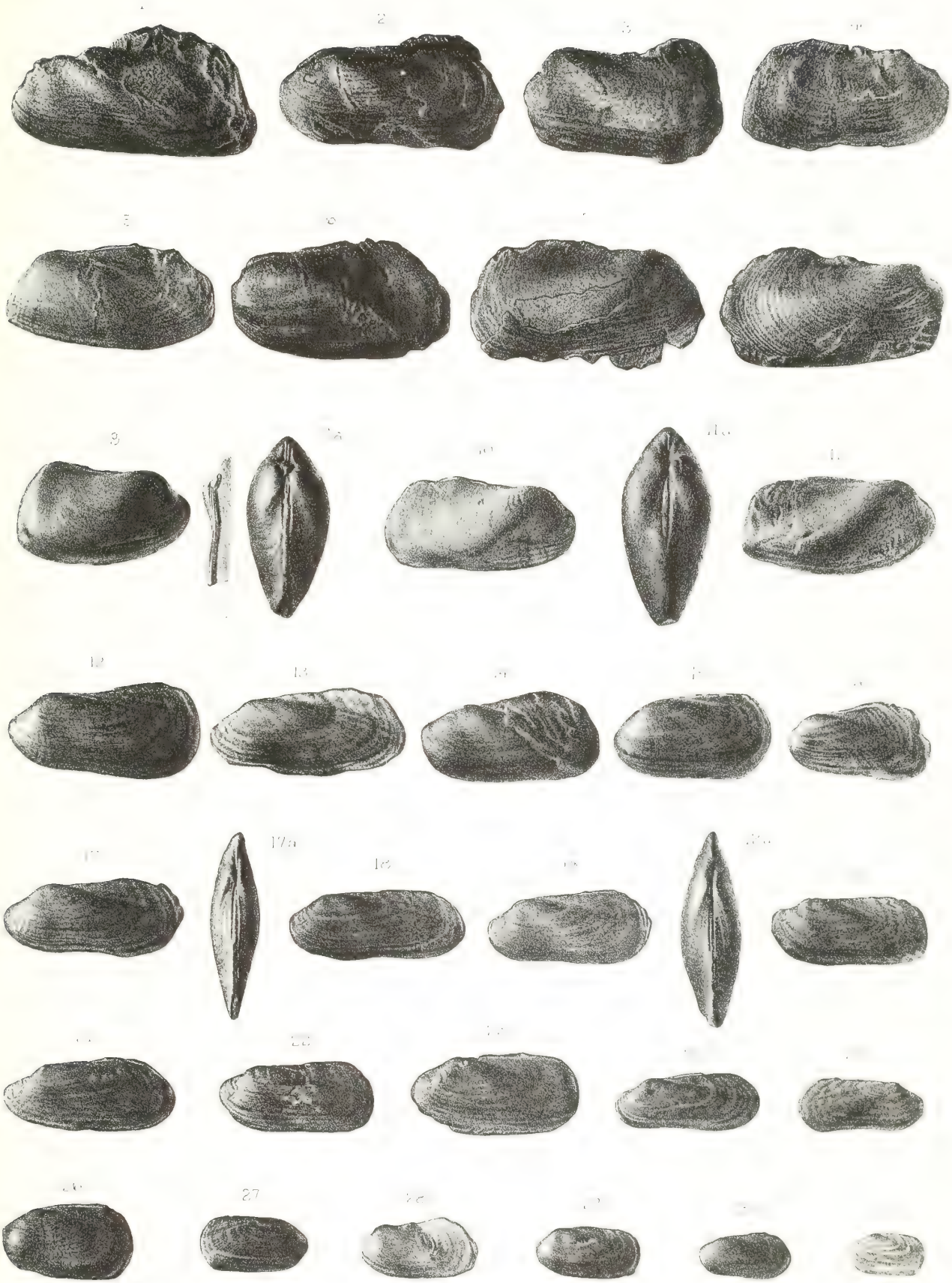
Fig. 10.—*Anthracomya modiolaris.* From Shettleston, Scotland. In the Collection of Mr. Beveridge of Glasgow. (Page 95.)

Fig. 11.—*Anthracomya modiolaris.* A cast from the Splint Coal, Wishaw. In the Braidwood Collection of Dr. Hunter. (Page 95.)

Fig. 11 *a*.—The same viewed from above.

Figs. 12—31.—*Anthracomya Williamsoni.* A series of all ages from the roof of the Hard Mine Coal at Adderley Green, North Staffordshire. My Collection. (Page 99.)

Fig. 32.—*Anthracomya modiolaris.* An example showing the hinge from Whitley, Northumberland. My Collection. (Page 95.)



Searle del et lith

## PLATE XV.

Figs. 1—4.—*Anthracomya Wardi.* Crushed forms from the lower part of the Little Mine Ironstone, Fenton. My Collection. (Page 105.)

Figs. 5—9.—*Anthracomya Williamsoni*, var. *obtusa.* From the roof of the Hard Mine Coal of Longton and Bucknall. My Collection. (Page 103.)

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Fig. 10.—*Anthracomya Williamsoni.* (Page 99.)

Fig. 11.—*Anthracomya lanceolata.* Horizon uncertain. From the Glebe Colliery, Fenton. My Collection. (Page 104.)

Fig. 11 *a.*—The same viewed from above.

Fig. 12.—*Anthracomya Wardi.* Young form from the roof of the Holly Lane or Bowling Alley Coal ?, Bucknall, North Staffordshire. My Collection. (Page 105.)

Fig. 13.—*Anthracomya Wardi.* From Burnley. In the Collection of the Manchester Museum, Owens College. (Page 105.)

Fig. 14.—*Anthracomya Wardi.* The type specimen from the shale over the Holly Lane ? Coal, Adderley Green, North Staffordshire Coal-field. Collection of Mr. John Ward, F.G.S. (Page 105.)

Fig. 15.—*Anthracomya Wardi.* Shale over Burnwood Ironstone, Chell. North Staffordshire Coal-field. My Collection. (Page 105.)

Fig. 16.—*Anthracomya Wardi.* ? From near Pendle. In the Collection of the Manchester Museum, Owens College. (Page 105.)

Fig. 17.—*Anthracomya Wardi.* Young form. Burnley. Same Collection. (Page 105.)

Fig. 18.—*Anthracomya Wardi.* Pyritised specimen from the Fulledge Colliery, Burnley. Collection of Mr. George Wild. (Page 105.)

Fig. 19.—*Anthracomya Wardi.* An uncrushed specimen from the neigbourhood of Burnley. Owens College Collection. (Page 105.)

Fig. 20. *Anthracomya Wardi.* From the shale above the Bowling Alley Coal at Whitfield, North Staffordshire Coal-field. My Collection. (Page 105.)

Fig. 21. *Anthracomya senex.* The original of the type of Mr. Salter's species; Iron-ores of South Wales, pl. ii, fig. 12. From the Collection of the Geological Survey, Jermyn Street, London. (Page 111.)

Fig. 21 *a.*—The same viewed from above, showing the hinge and wrinkled periostracum.

Figs. 22—28.—*Anthracomya senex.* A series from the horizon of the Cockshead Ironstone of Adderley Green, North Staffordshire. My Collection. (Page 111.)

Figs. 29—49.—*Anthracomya pulchra.* A series showing the alteration of shape during growth. From the lower part of the Burnwood Ironstone, Newchapel, North Staffordshire Coal-field. My Collection. (Page 114.)

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# PLATE XVI.

Fig. 1.—*Anthracomya subcentralis.* From No. 6 Pit, Victoria, South Wales Coal-field. In the Collection of the Cardiff Museum. (Page 109.)

Figs. 2 and 3.—*Anthracomya pumila.* Same Collection. (Page 108.)

Fig. 4.—*Anthracomya subcentralis.* From the roof of the Hard Mine Coal, Adderley Green, North Staffordshire Coal-field. My Collection. (Page 109.)

Figs. 5—9.—*Anthracomya subcentralis.* A series of crushed examples from the horizon of the Cockshead Ironstone, Hulme Colliery, Longton. My Collection. (Page 109.)

Fig. 10.—*Anthracomya Phillipsii.* The type specimen. From the Upper Coal-measures, Ardwick. In the Collection of the Manchester Museum, Owens College. (Page 120.)

Fig. 11.—*Anthracomya Phillipsii.* From the Bassey Mine Ironstone, Chatterley, North Staffordshire. My Collection. (Page 120.)

Figs. 12, 13, 13 *a*, 14.—*Anthracomya Phillipsii.* Complete specimens from the Knowles Ironstone, Fenton. My Collection. (Page 120.)

Fig. 15.—*Anthracomya Phillipsii.*—An elongate form from the Bassey Mine Ironstone, Chatterley, North Staffordshire. My Collection. (Page 120.)

Fig. 16.—*Anthracomya Phillipsii.*—Like the type; from the Bassey Mine Ironstone of Chatterley, North Staffordshire. My Collection. (Page 120.)

Figs. 17 and 19.—*Anthracomya lævis*, var. *Scotica.* Limehouse Water, West Calder; Lower Carboniferous. Collection of the Geological Survey of Scotland. (Page 123.)

Fig. 18.—*Anthracomya lævis*, var. *Scotica.* The type figured by Mr. R. Etheridge, jun., 'Geol. Mag.,' 1877, dec. 2, vol. iv, pl. xii, fig. 8. Same Collection. (Page 123.)

Fig. 20.—*Anthracomya lævis*, var. *Scotica?* Water of Leith. This specimen was labelled by Mr. R. Etheridge, jun., *Anthracoptera papyracea*, MS., doubtless on account of the sinuated posterior border. Same Collection. (Page 123.)

Figs. 21, 22.—*Anthracomya minima.* Large specimens from Black Adder Water, Duns; Lower Carboniferous of Scotland. Same Collection. (Page 116.)

Fig. 23.—*Anthracomya lævis.* A specimen from the South Joggins Coal-field, Nova Scotia. My Collection. (Page 123.)

Figs. 24, 26—30.—*Anthracomya minima.* From the Middle Coal-measures of Lancashire Coal-field, Prestolee, in a band of ironstone. My Collection. (Page 116.)

Figs. 25, 31—34.—*Anthracomya minima.* From the Knowles Ironstone. Railway-cutting north of Golden Hill, North Staffordshire. My Collection. (Page 116.)

Figs. 35—39.—*Anthracomya minima*, var. *carinata.* From Prestolee, Middle Coal-measures, Lancashire. In the Collection of C. Roeder, Esq., of Manchester. (Page 119.)

Fig. 40.—*Anthracomya pumila.* Coal-measures, Merthyr Tydvil. From the Strickland Collection, Woodwardian Museum. (Page 108.)

Fig. 41.—*Anthracomya obovata.* From the roof of the Hard Mine Coal, Mossfield Colliery, Longton. My Collection. (Page 110.)

Figs. 42, 43.—*Anthracomya lævis*, var. *Scotica.* From the Cannel Coal, Wigan. My Collection. (Page 123.)

Figs. 44—48.—*Anthracomya Valenciensis.* From Dalmeny railway-cutting. Lower Carboniferous of Scotland. Collection of the Geological Survey of Scotland. (Page 113.)

Fig. 44 *a*.—The shell of fig. 44 viewed from above. (Page 113.)

Fig. 49.—*Anthracomya modiolaris.* One of the original type specimens figured by Mr. Sowerby in Professor Prestwich's 'Geology of Coalbrookdale.' In the Collection of the Natural History Museum, South Kensington. (Page 95.)

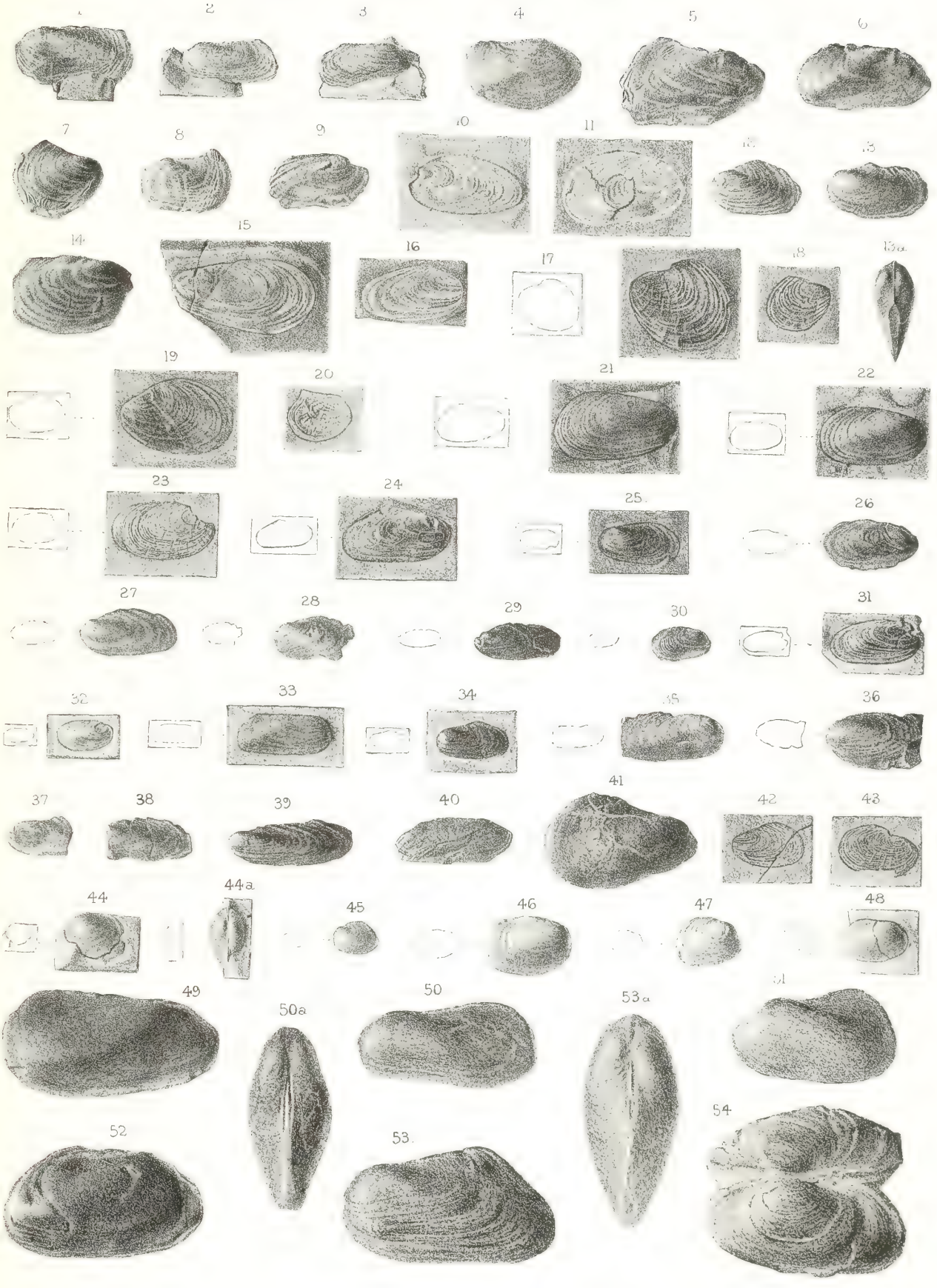
Figs. 50, 50 *a*.—*Anthracomya modiolaris.* Two views of the second type specimen figured by Mr. Sowerby in the above work, a view only, as in 5 *a*, being given. The same Collection. (Page 95.)

Fig. 51.—*Anthracomya modiolaris.* A specimen like Mr. Salter's type (Pl. XIV, fig. 9), from Coalbrookdale. In the same Collection. (Page 95.)

Fig. 52.—*Anthracomya modiolaris.* From the Middle Measures? of the Durham Coal-field. My Collection. (Page 95.)

Fig. 53.—*Anthracomya modiolaris.* From the Grains Ironstone, Dudley, South Staffordshire Coal-field. My Collection. (Page 95.)

Fig. 54.—*Anthracomya Adamsii?* An aberrant form from the South Wales Coal-field. In the Collection of the Cardiff Museum. (Page 89.)

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## PLATE XVII.

Figs. 1 and 2.—[*Modiola*] *Macadami*, var. *subparallela*. From the Ballycastle Coal-measures, co. Antrim. In the Collection of Mr. Joseph Wright of Belfast. (Page 88.) Since page 88 was printed I have discovered from a fine specimen in the Belfast Museum, showing the hinge, that the shells from Ballycastle now figured are not of the genus Modiola, but belong to the Anthracomyæ.

Fig. 3.—*Anthracomya subcentralis*. The roof of the Four-foot Coal, Bilboa, Castlecomer. Collection of the Geological Survey, Jermyn Street. (Page 109.)

Figs. 4 and 5.—*Anthracomya subcentralis*. Bilboa, Queen's Co. Collection of the Geological Survey of Ireland, Dublin. (Page 109.)

Figs. 6 and 7.—*Anthracomya Williamsoni*. Same locality and Collection. (Page 99.)

Figs. 8, 9, 10, 12—15.—*Naiadites modiolaris*. Showing the striated hinge-plate; obsolete anterior hinge-tooth and trifid anterior adductor scars. From the Shale above the Bowling Alley Coal, Hanley and Bucknall Colliery, North Staffordshire. My Collection. (Page 131.)

Fig. 11.—*Naiadites?* sp. A portion of the shell magnified to show prismatic structure, from a specimen sent me by Dr. John Young of the Hunterian Museum. (Page 131.)

Figs. 16, 16 *a*, 18, 18 *a*.—*Naiadites modiolaris*. Two views of two casts showing anterior and posterior muscle-scars and the mantle-line. Roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 131.)

Fig. 17.—*Naiadites modiolaris*. To show the flattened right valve. Same locality and Collection. (Page 131.)

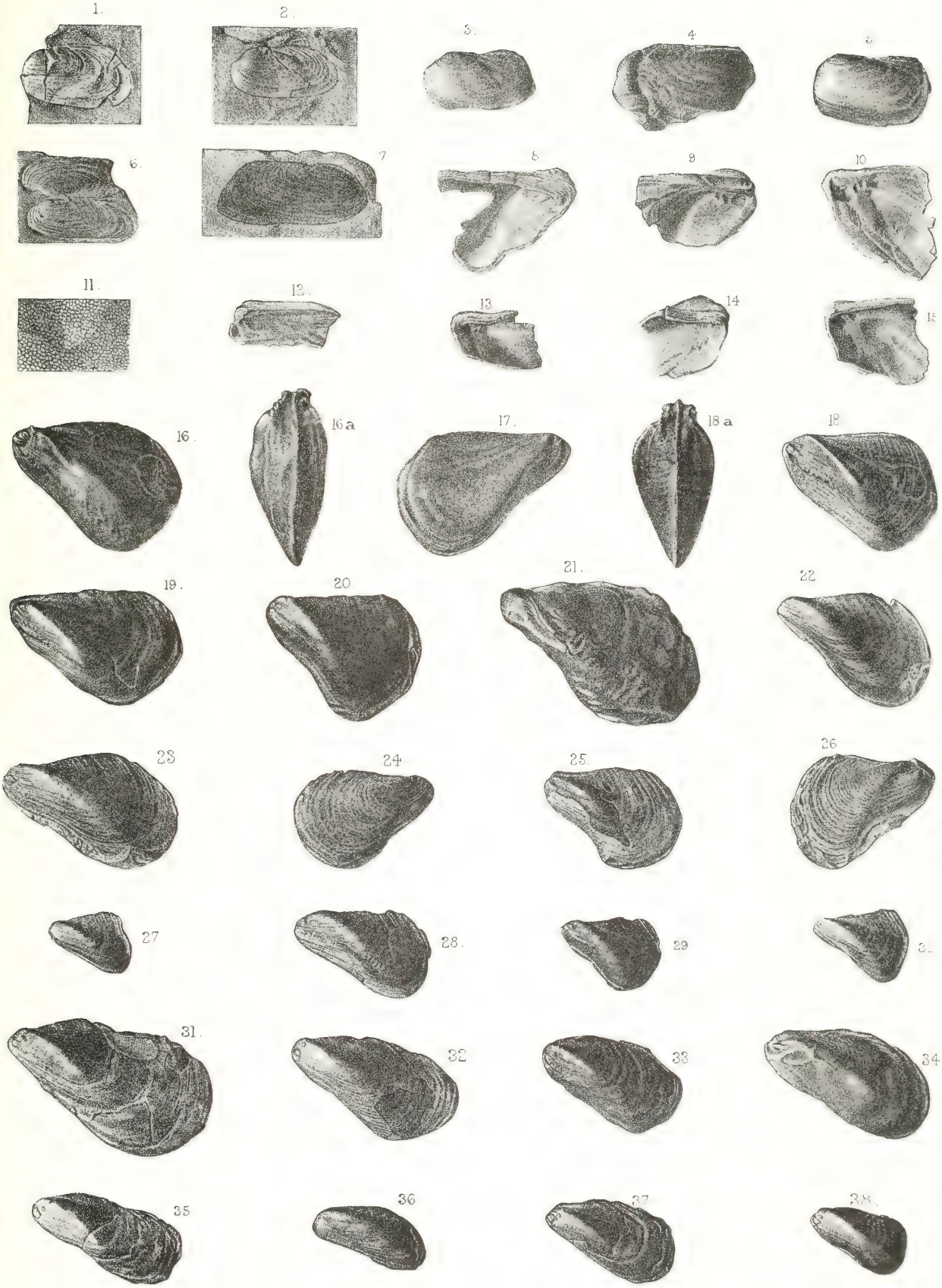
Figs. 19, 20.—*Naiadites modiolaris*. To show variation in contour. Same locality and Collection. (Page 131.)

Fig. 21.—*Naiadites modiolaris*. From the locality whence the types were procured. Coalbrookdale. My Collection. (Page 131.)

Figs. 22—26.—*Naiadites modiolaris*. Testiferous specimens showing lines of growth and variation in shape. Roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 131.)

Figs. 27—30.—*Naiadites modiolaris*. A series of young specimens from the same locality. My Collection. (Page 131.)

Figs. 31—38.—*Naiadites triangularis*. A series showing the changes resulting during growth. From the same locality. My Collection. (Page 135.)

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## PLATE XVIII.

Figs. 1—5.—*Naiadites carinata.* A series of casts showing the muscle-scars and line of the mantle, and the variation of contour. From the roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 138.)

Figs. 4 and 5.—*Naiadites carinata.* Testiferous examples from the same locality. My Collection. (Page 138.)

Figs 7—9.—*Naiadites carinata.* Casts from the Stanley Main Seam, Wakefield. My Collection. (Page 138.)

Figs. 10, 11, and 15.—*Naiadites carinata.* Young examples from the roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 138.)

Fig. 12.—*Naiadites carinata.* An obese form from the same locality. My Collection. (Page 138.)

Figs. 13, 14.—*Naiadites carinata.* Two views of a very obese form showing the much-wrinkled periostracum. Same locality. My Collection. (Page 138.)

Fig. 15.—*Naiadites carinata.* A testiferous specimen of moderate growth. Same locality. My Collection. (Page 138.)

Fig. 16.—*Naiadites carinata.* An aberrant form from the same locality. In the Collection of John Ward, Esq., F.G.S., of Longton. (Page 138.)

Fig. 17.—*Naiadites quadrata.* A large compressed form from the roof, Hard Mine Coal, North Staffordshire. My Collection. (Page 140.)

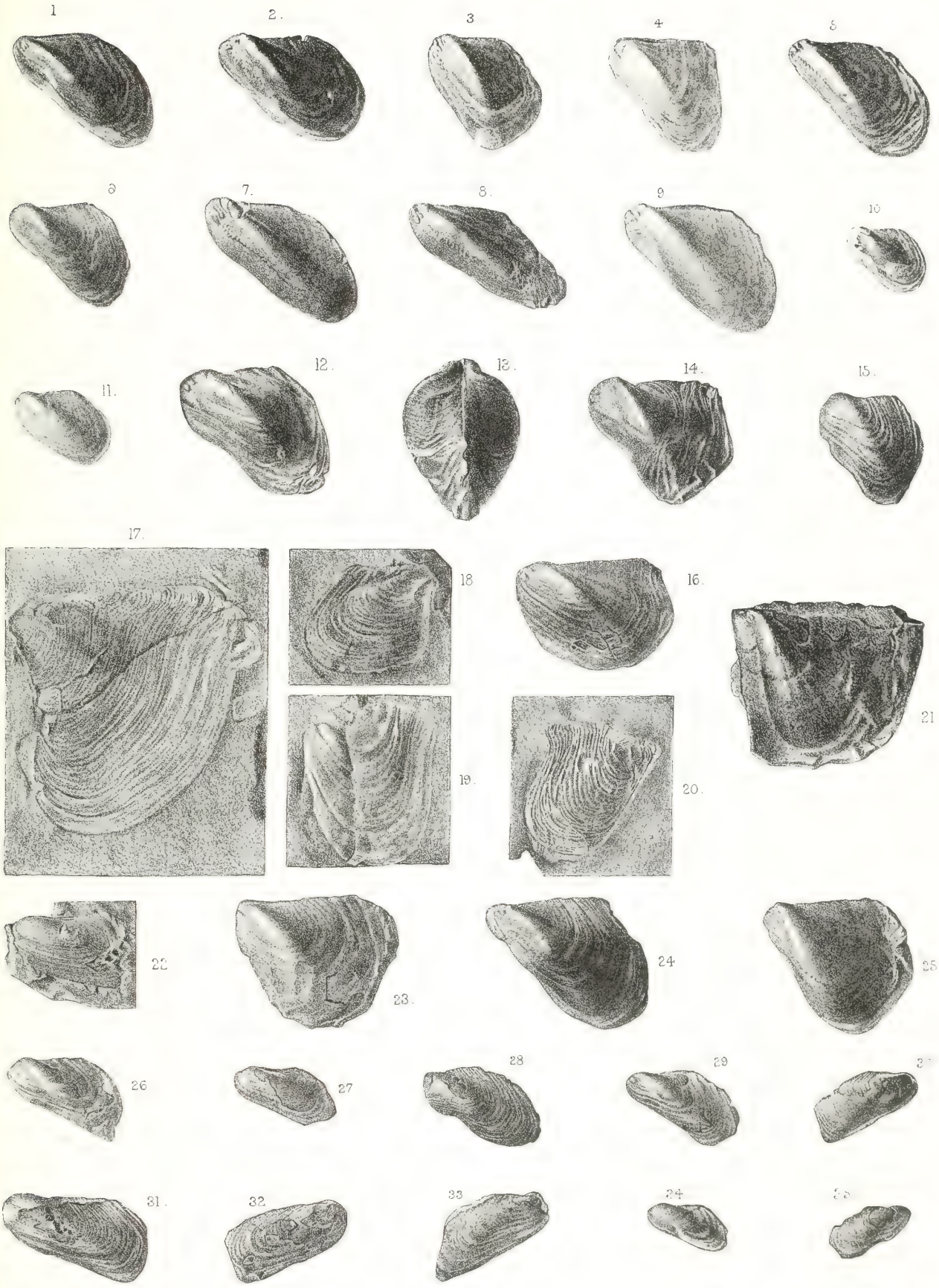
Figs. 18 and 19.—*Naiadites quadrata.* Crushed examples from the Burnwood Ironstone, Fenton. My Collection. The artist has drawn this shell with its anterior side uppermost. (Page 140.)

Fig. 20.—*Naiadites quadrata.* A crushed testiferous example from above the Woodhead Coal of Froghall. My Collection. (Page 140.)

Figs. 21, 23—25.—*Naiadites quadrata.* Uncrushed examples from the roof of the Hard Mine Coal, Adderley Green, North Staffordshire. My Collection. (Page 140.)

Fig. 22.—*Naiadites elongata.* From the Ironstone Band in the Middle Coal-measures of the Lancashire Coal-field, Prestolee. (Page 142.)

Figs. 26—35.—*Naiadites elongata.* A series from the Knowles Ironstone of Fenton Park, North Staffordshire, figs. 31 and 32 being the type forms. (Page 142.)

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## PLATE XIX.

Figs. 1—7.—*Naiadites obesa.* A series of weathered specimens showing the structure of the hinge, and the pits for the anterior muscles. From the Calciferous-Sandstone Series of Fife. My Collection. (Page 144.)

Fig. 8.—*Naiadites obesa.* A specimen of a right valve, showing the emarginate posterior border. From Oakbank Quarry, Midcalder. My Collection. (Page 144.)

Figs. 9 and 10.—*Naiadites obesa.*—Two right valves from the Calciferous Sandstone-Series of Kilrenny Mill, Fife. My Collection. (Page 144.)

Fig. 11.—*Naiadites obesa.* A left valve. From the same locality. My Collection. (Page 144.)

Figs. 12—14.—*Naiadites obesa.* The originals of Mr. R. Etheridge's, jun., *Anthracoptera tumida.* From the Shale above the "Brownstone" portion of the Boness Lower Ironstone. Edge-Coal Series. Collection of the Geological Survey of Scotland, Edinburgh. (Page 144.)

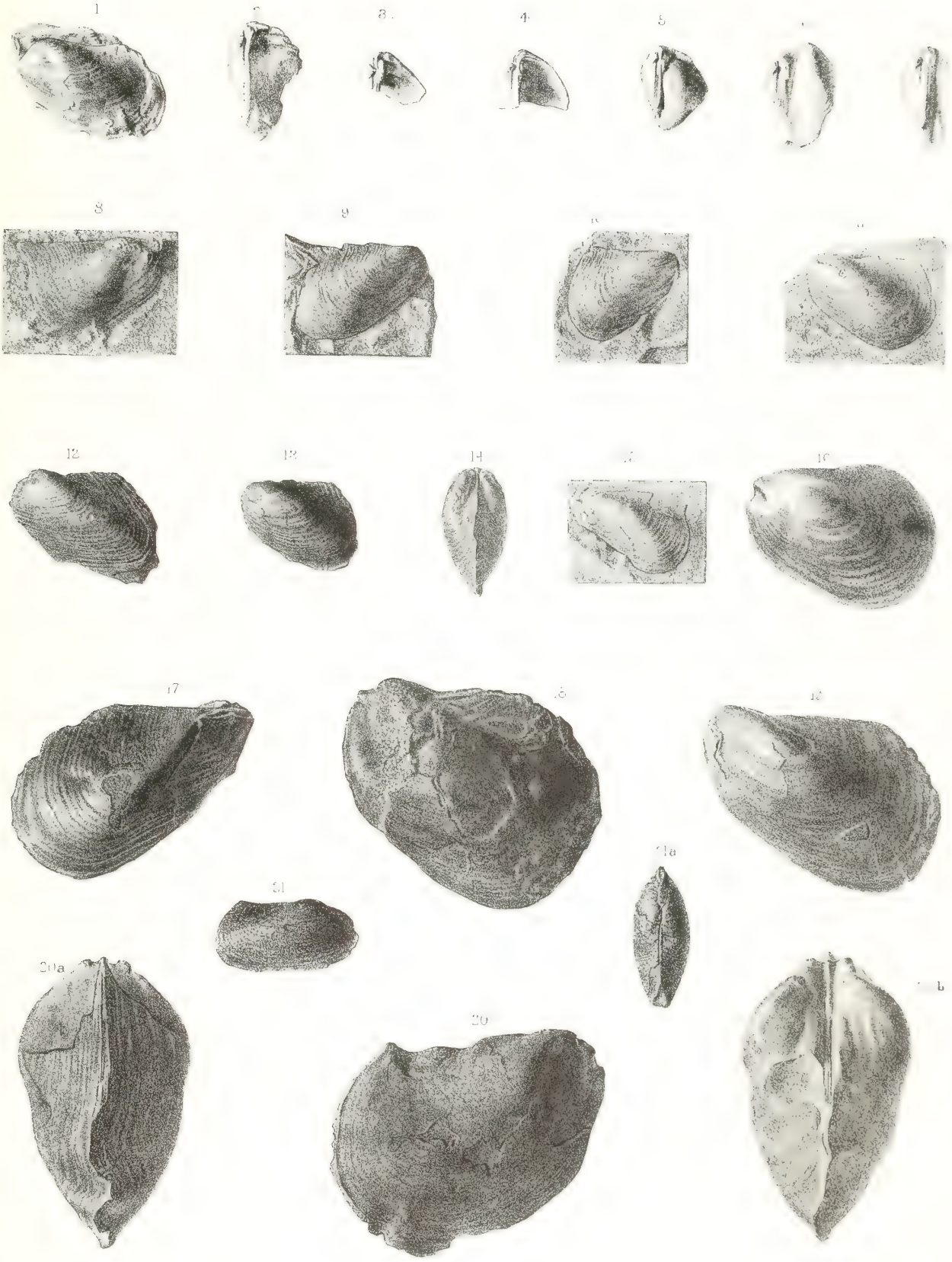
Fig. 15.—*Naiadites obesa.* A left valve with the shell removed in front, showing the tubercles representing the pits for the muscle-scars. Kilrenny Mill. My Collection. (Page 144.)

Fig. 16.—*Naiadites obesa.* The largest of the original shells figured by Mr. R. Etheridge, jun., 'Quart. Journ. Geol. Soc.,' vol. xxxiv, 1878, pl. i, fig. 12 *a*. From Micaceous Sandstone, Drumsheugh. In the Collection of the Museum of Science and Art, Edinburgh. (Page 144.)

Figs. 17—19.—*Naiadites magna*, n. sp. From the Black Band Ironstone, Bankend, Lesmahagow. From the Braidwood Collection of Dr. Hunter. (Page 151.)

Figs. 20, 20 *a*, 20 *b*.—*Naiadites magna.* Three views of a large example, showing the typical cast of the anterior end and the sinuated folding at the posterior inferior angle. From the same locality and Collection. (Page 151.)

Figs. 21, 21 *a*.—*Anthraconya subcentralis.* Two views of a typical specimen, showing the gibbosity of the shell. From the original locality, South Wales. In the Collection of the Geological Survey, Jermyn Street. (Page 109.)

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## PLATE XX.

Figs. 1, 2, 3, and 7.—*Naiadites crassa.* A series of valves showing the striated hinge-plate, and almost obsolete cardinal tooth and pit-like muscle-scars. From the Cults Lime Works, Pitlessie, Fife. My Collection. (Page 147.)

Fig. 4.—*Naiadites crassa.* A specimen with the valves united, but slightly displaced. Same locality. My Collection. (Page 147.)

Fig. 5.—*Naiadites crassa.* A dwarf variety. From the Wardie Shales, Woodhall, Water of Leith. My Collection. (Page 147.)

Fig. 6.—*Naiadites crassa.* External view of fig. 5.

Fig. 8.—*Naiadites crassa.* The worn surface of a left valve. From Cults, Pitlessie, Fife. My Collection. (Page 147.)

Fig. 9.—*Naiadites crassa.* A specimen exhibiting both valves spread open. From the Carboniferous-Limestone Series, Beith, Ayrshire. In the Collection of Mr. J. Neilson, of Glasgow. (Page 147.)

Fig. 10.—*Naiadites crassa.* A cast showing mantle-line and muscle-scars. From the same locality and Collection. (Page 147.)

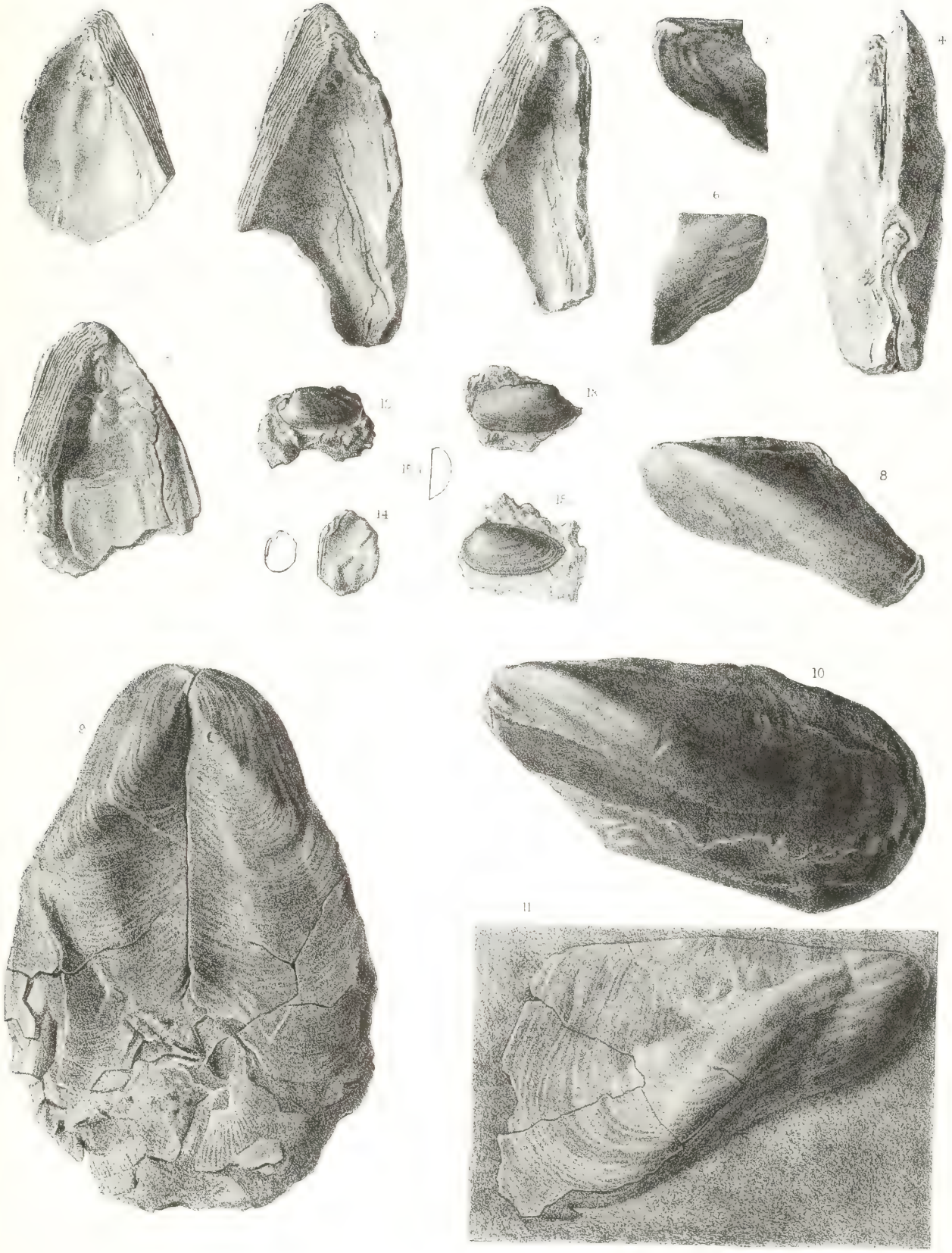
Fig. 11.—*Naiadites crassa.* A fairly perfect right valve, showing dimensions. From Cults Lime Works, Fife. My Collection. (Page 147.)

Fig. 12.—*Carbonicola elegans.* A cast showing muscle-scars. From the Calciferous-Sandstone Series, East of Pittenweem. (Page 81.)

Figs. 13 and 15.—*Carbonicola elegans.* A right and a left valve. From the same locality. (Page 81.)

Fig. 15 *a*.—*Carbonicola elegans.* A line to show the vertical curvature of the valve. (Page 81.)

Fig. 14.—*Carbonicola elegans.* The hinge enlarged to twice its size. From the same locality. (Page 81.)

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THE

# PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1895.

LONDON:

MDCCCXCV.

# A MONOGRAPH

OF THE

# DEVONIAN FAUNA

OF THE

# SOUTH OF ENGLAND.

BY

G. F. WHIDBORNE, M.A., F.G.S.

VOL. II.—PART IV.

## THE FAUNA OF THE LIMESTONES

OF

## LUMMATON, WOLBOROUGH, CHIRCOMBE BRIDGE, AND CHUDLEIGH

(*continued*).

PAGES 161—212; PLATES XVIII—XXIV.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1895.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

## 2. Class.—BRYOZOA, *Ehrenberg*, 1832.

The question whether these animals should rightly be known as *Polyzoa* or as *Bryozoa* appears very intricate; although for the reasons given below *Polyzoa* appears the more correct term, *Bryozoa* is here used for convenience.

In 1830 J. V. Thompson published a paper "on *Polyzoa*, a new animal discovered as an inhabitant of some zoophytes, with a description of the newly instituted genera . . . . and three species."

In this paper he uses *Polyzoa* as a singular feminine designation of the soft parts of the animal, in parallelism with *Hydra*, *Actinia*, *Ascidia*, *Zoantha*, so that it has an equal value with these words, and he intimates that it may be a "new type of *Mollusca Acephala*." He, moreover, establishes certain genera, basing them on the hard parts of the animal. Thus he writes, "Although the animals of *Seriolaria* have not yet been observed, yet, from . . . , there can hardly be a doubt but they are the habitations of *Polyzoæ* and not of *Hydræ*, and consequently would find place in our system next *Vesicularia*."

The first question seems, therefore, to be whether the word so used can be regarded as a zoological or an anatomical term; whether it can be looked on as defining a class of animals, or merely as a structural name for the contents of their zoaria; whether, in fact, Polyzoæ meant a natural zoological group of animals, or simply described their soft parts anatomically; that is, whether Thompson regarded the hard parts as skeletal or domiciliary,—whether they were counted, for instance, in the category of the bones or of the burrows of rodents. With their real nature, of course, we have nothing to do, the question being simply what Thompson meant.

Now, from the words above quoted, it is clear that he called the soft parts the animal. He states that "*Seriolaria* are probably the habitations of *Polyzoæ* and not *Hydræ*, though the animals themselves have not been discovered." Therefore it appears that he considered *Polyzoæ* as "the animals," and as a broad name of a group of the Mollusca.

We, therefore, I think, arrive at the conclusion that *Polyzoæ* was given by Thompson as the name for the type of animals which Ehrenberg afterwards grouped among his *Bryozoa*.

But the same name *Polyzoa* appears to have been already employed by Lesson for an Ascidian, and it is asserted that, though in one case it is simply generic, and in the other, as first used, had wider though undefined limits, and though, as Hincks[1] asserts, it never was much used, and has at present lapsed, yet the laws of nomenclature would, at least in spirit, oblige us to regard it as being

[1] 1880, Hincks, 'British Marine Polyzoa,' vol. i, p. cxxxii.

seems best to assign the position of type to his var. γ, which is represented by his figures 36 *a* and *b*. To the species thus restricted may safely be referred a Lummaton form with which his description fairly corresponds.

At the same time his definition of both species is too slight to be satisfactory; and, even after the examination of his type specimens, some doubt may remain about their proper identification and limits.

Lonsdale's figures and description[1] of *F. antiqua?* from Devonshire are quite unidentifiable, and probably include several species without distinction.

Lastly, M'Coy,[2] leaving *F. antiqua*, Goldfuss, as the name of the species from the Plymouth Limestone, separates the South Petherwyn and Carboniferous specimens under the name of *F. plebeia*, M'Coy.

On the whole it appears probable that there was no real ground for identifying any of these British fossils with those described by Goldfuss.

It will be seen further on that several fresh species must be added to the Devonian list. The material at my disposal has been insufficient to permit very satisfactory conclusions in some cases; but it is evident not only that the number of species of *Fenestella* must be increased, but that there are interesting evidences of several other genera. Even where these evidences are too meagre for the full description of a species, they suffice to indicate its existence.

In my attempts to decipher these fossils I have to acknowledge the very great kindness of Dr. J. W. Gregory, without whose frequent help I could not have got even so far towards their interpretation as I have been able to do. The transparent sections which have been very kindly prepared for me by Mr. F. Chapman have also thrown light on many points of structure which would otherwise have been unattainable. I have followed Ulrich in his classification and generic definitions.

## 1. Order.—GYMNOLÆMATA, *Allman*, 1856.

### 1. Sub-order.—CRYPTOSTOMATA, *Vine*, 1883.

Zoarium, either bifoliate, or arranged in single layers forming fenestrated expansions, or ramose with the zoœcia arising from a real, or imaginary, axis. Primitive cell generally with the orifice produced into a tubular shaft or vestibule.

#### I. *Family*.—Fenestellidæ, *King*, 1849.

Zoarium forming rigid reticulate expansions, celluliferous on one side, consisting of branches generally either united by dissepiments or anastomosing. Primitive

[1] 1840, Lonsdale, 'Geol. Trans.,' ser. 2, vol. v, pt. 3, pl. lviii, figs. 10—10 *b*.

[2] 1851, M'Coy, 'Brit. Pal. Foss.,' p. 75.

part of cell oblong, quadrate, or hexagonal in outline. Superior hemiseptum usually present. Primitive aperture semi-elliptic. Superficial aperture rounded with peristome (and in the perfect state closed by a centrally perforated operculum).

### 1. *Genus.*—Fenestella, *Lonsdale*, 1839.

"Zoarium flabellate to infundibuliform, poriferous on the inside (always?), branches nearly straight, and united at rhythmical intervals by non-poriferous dissepiments. Zoœcia in two rows, separated by a more or less developed median keel."[1] Silurian to Trias.

Originally defined by Lonsdale,[2] this genus was afterwards considerably extended by him,[3] and then again restricted by King,[4] whose definition does not differ materially from that adopted by Ulrich, and given above. It may, however, be noticed that Phillips distinguishes the genus from *Retepora* by its having the poriferous side external; but Lonsdale and King describe this as sometimes internal and sometimes external, while Ulrich describes it as "on the inside (always?)."

It appears from Scudder[5] that the name *Fenestella* was used in 1819 by Bolton ('Mus. Ed.,' ii, p. 134) for some bivalve. I have been unable to trace this reference further, but expect that it probably is a mere unauthoitative catalogue name, as it has never been recognised as valid for a mollusc.

1. Fenestella fanata,[6] n. sp. Pl. XVIII, figs. 6—10, and Pl. XIX, figs. 3, 4.

| | | | | |
|---|---|---|---|---|
| 1840. | Fenestella antiqua, | *Lonsdale* (not *Goldfuss*), | pars. | Geol. Trans., ser. 2, vol. v, pt. 3, pl. lviii, figs. 10—10 *b*. |
| 1841. | — | — | *Phillips*, pars. | Pal. Foss., p. 24, pl. xii, fig. 35 $\beta$, $\gamma$ (only). |
| 1849. | — | — | *d'Orbigny*. | Prodrome, vol. i, p. 101. |

*Description.*—Zoarium widely cup-shaped, growing from a wide base. Fenestrules 8 or 9 in the length of 10 mm., and 16 in the width of 10 mm.; elongate, oval or oblong, rather variable in size and shape in different parts of the same frond. Branches narrow, not very straight, subcircular in section, about the same width as the fenestrules, though sometimes wider or narrower, swelling

[1] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 395.
[2] 1839, Lonsdale, in 'Murch. Sil. Syst.,' vol. ii, p. 677.
[3] 1845, Lonsdale, in Murchison, Keyserling, and Verneuil, 'Russia,' Appendix A, p. 629.
[4] 1851, King, 'Permian Fossils,' p. 34.
[5] 1882, Scudder, 'Nomenclator Geol.,' p. 138.
[6] Lummaton being in the parish of St. Mary Church.

*Affinities.*—The present species is really much nearer to *Fenestella plebeia*, M'Coy ;[1] but, judging both from his description and figures, and from some well-preserved Carboniferous specimens from the Halkyn Mountains, I think there can be no doubt that they are perfectly distinct. *F. plebeia* is flabellate or fan-shaped instead of infundibuliform or cup-shaped, the branches are coarser and straighter, the cell-mouths larger, and the carinæ very much stronger. The bifurcations also seem to occur more nearly at the same level in different branches, the dissepiments seem slighter, and the fenestrules longer and narrower. It may be remarked, on the other hand, that in all the points that are observable, as well as in its measurements, the common Pilton *Fenestella* agrees with these Carboniferous specimens, and therefore I have no doubt that M'Coy is correct in identifying that North Devon form as *F. plebeia*. Shrubsole[2] regarded *F. plebeia* as the equivalent of *G. antiqua*, Goldfuss.

The other Carboniferous species described by Phillips or M'Coy, which are at all similar in other respects, may be distinguished by their much stronger carinæ, except *F. hemisphærica*,[3] which is very much smaller in structure.

*F. explanata*, F. A. Römer,[4] which is identified by its describer with *F. antiqua*, Phillips (not Goldfuss), seems distinguished by its much stronger carinæ, stouter dissepiments, and perhaps by the wavy margins of its branches.

*F. micropora*, F. A. Römer,[5] of the Iberger Kalk, is much more like it. Römer defines it as having the branches as wide as the dissepiments, three or four small cells to a fenestrule, and a conical zoarium. This is, however, but little for specific discrimination, especially as the size of the fenestrules is not given; the latter, moreover, seem shorter and squarer than in the English species, so that it does not seem safe to identify them without further evidence.

Of the American species given by Ulrich none approach it at all closely. Perhaps the nearest is *F. modesta*, Ulrich,[6] but it has slighter branches, smaller fenestrules, and a granulated external surface.

From the common Pilton fossil, *F. plebeia*, it appears to be distinguished by its rather coarser network, less straight branches, and probably less prominent pores.

[1] 1844, M'Coy, 'Syn. Carb. Foss. Ireland,' p. 203, pl. xxix, fig. 3.
[2] 1880, Shrubsole, 'Quart. Journ. Geol. Soc.,' vol. xxxvi, p. 242.
[3] 1844, M'Coy, 'Syn. Carb. Foss. Ireland,' p. 202, pl. xxix, fig. 4.
[4] 1850, F. A. Römer, 'Beitr. Harz.,' pt. 1, p. 7, pl. i, figs. 12 *a*, *b*.
[5] 1855, ibid., pt. 3, p. 34, pl. vi, fig. 26.
[6] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 550, pl. lii, figs. 3—3 *b*.

2. Fenestella delta, n. sp. Pl. XIX, fig. 2.

*Description.*—Zoarium in parts flat, with slightly undulating, narrow branches, united by stout, short, and low non-poriferous dissepiments. Branches strongly obtusely keeled, with flat, oblique sides, bearing a row of cells with slightly elevated round mouths, with thickened peristomes, at the rate of five or six cells to a fenestrule. Fenestrules oblong or suboval, about 8 in 10 mm. of length, and 12 in 10 mm. of width.

*Size* of fragment about 7 mm. wide.

*Locality.*—Lummaton. One small specimen in my Collection.

*Remarks.*—I have been able to identify only one single small fragment of this species, and therefore can form no opinion as to the manner of growth of its zoarium. It seems, however, to be a very distinct form, differing from the common Lummaton *Fenestella fimata* by the triangular and strongly keeled shape of its branches, and by having about six instead of three (or four) pores to a fenestrule. I think, therefore, there is every reason for adding it to the list, although it would have been more satisfactory to have had further evidence of its character. From Pilton specimens of *F. laxa*, Ph., it is distinguished by its stronger branches and dissepiments, its less angular fenestrules, and the smaller number of its cells.

This seems the nearest approach among our Devonian fossils to *F. antiqua*, Goldfuss, sp.;[1] but it appears to be clearly distinguishable by its narrower fenestrules and more numerous cells to a fenestrule. Goldfuss describes his species as occurring both in the Devonian and the Zechstein, figuring a fragment, natural size, from the former, and another, enlarged, from the latter, while his description is too broad for specific distinction. Thus the only thing to be relied on is the enlarged figure, which probably represents a distinct dolomitic species. It would not, therefore, be safe to identify our fossil with *F. antiqua*, especially as we have seen that under this name different authors refer to more than one of the species which Goldfuss has described, and it remains to be decided which of them has the prior claim to that name.

*Affinities.*—*F. regalis*, Ulrich,[2] very closely approaches it, but seems to have much larger fenestrules, more numerous cells, and closer mouths.

*F. funicula*,[3] Ulrich, comes still nearer, but may, I think, be distinguished by its laxer growth, longer fenestrules, more central apertures, and rather more strongly corded keel; while *F. Cestriensis*, Ulrich,[4] has smaller fenestrules, less undulating

[1] 1826–33, Goldfuss, 'Petref. Germ.,' vol. i, p. 99, pl. xxxvi, figs. 3 *a*, *b*.

[2] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 538, pl. l, figs. 1, 1 *a*; and pl. liv, fig. 5.

[3] Ibid., p. 542, pl. li, fig. 6.

[4] Ibid., p. 547, pl. li, figs. 5—5 *b*.

branches, and apparently less prominent peristomes. Our species thus comes nearly midway between *F. Cestriensis* and *F. funicula*.

Of the Carboniferous species described by Phillips and by M'Coy *F. polyporata*, Ph.,[1] approaches the present species most nearly, but it seems to be distinguished by having a larger number of cells, and by the total absence of a keel, which makes M'Coy regard it as approaching the confines of the genus *Polypora*.

3. Fenestella arthritica, *Phillips*. Pl. XIX, figs. 5—10.

? 1827. Retepora antiqua, *Goldfuss*. Petref. Germanica, p. 28, pl. ix, figs. 10 *a*, *b*.
1841. Fenestella arthritica, var. γ, *Phillips*. Pal. Foss., p. 25, pl. xii, figs. 36 *a*, *b* (only).

*Description*.—Zoarium in flattish expansions. Fenestrules regularly oval and very uniform in size, about eight to the length of 10 mm., and thirteen or fifteen to the breadth of 10 mm. Branches rather narrower than the fenestrules, thickening at the dissepiments (so that when the latter alternate the branches are even and slightly undulating, and when they are level the branches are straight and nodulous), divaricating very slowly, often not once in fifteen fenestrules. Dissepiments broad, bi-concave, as large as the branches. Branches divided by a strong, straight, central wall, which is continued upward to a height equal to that of the cells in a thin, free keel or knife-edge, on each side of which is a row of parallel or alternate cells at the rate of four to a fenestrule, with large, circular, elevated mouths. Cells large, suboval in horizontal section, oblong in perpendicular longitudinal section, and oval in perpendicular transverse section, the height of the cells being greater than their width. Cell-mouths large, circular, elevated. Non-poriferous face of branches very convex transversely, covered with several irregular rows of tubercles or nodes, and in section showing a thick coat of dense tissue permeated by some very minute, irregular, longitudinal veins or canals, and of a thickness equal to the height of the cells. Poriferous face having a similar but thinner coat, which differs from the other by being without venation and in having numerous, small, tubular processes permeating it almost perpendicularly and rising above its surface.

*Size of Fragment*.—23 mm. by 18 mm.

*Locality*.—Lummaton. Four or five specimens are in my Collection, besides some which have been used for sections.

[1] 1836, Phillips, 'Geol. York,' vol. ii, p. 199, pl. i, figs. 19, 20; and 1844, M'Coy, 'Syn. Carb. Foss. Ireland,' p. 203.

*Remarks.*—The type of Phillips's *F. arthritica,* var. γ, is in the Museum of Practical Geology, and came from Hope's Nose. No structure can be seen in it except a coarse nodulation on the reverse of the branches; but in that and in its general character it is so similar to the present fossils that there is little doubt that they are identical. It appears to be a flabellate form growing from a large base of attachment. It is by no means so easy to say whether *F. arthritica,* vars. α and β, are the same species; and if not, which should have the right to precedence, for though his var. γ ranks third in the text, it ranks first in the Plate. Of his figures, 36 *a* and *b* evidently represent his var. γ, 36 *c* represents his var. β, and 36 *e* his var. α, which he himself calls "a variety." But the two latter are not so clearly defined as the former, and possibly may never be satisfactorily identified. Therefore we may fairly claim Phillips's name for the present species, and leave the others to receive new names if they should ever be proved distinct.

Under the name *Retepora antiqua*, Goldfuss described a fossil which is not very dissimilar, though differing by having smooth and rather stouter branches. Its cells, size, and other features are unknown, and it seems hopeless to attempt to identify it specifically. It is perfectly distinct from *Gorgonia antiqua,* Goldfuss (which is the original of Lonsdale's and Phillips's *F. antiqua*, Goldfuss), though it seems to have been in M'Coy's mind in defining the British species. Even, therefore, if it were the same as our species, which is more than doubtful, it would be only adding to the confusion to adopt Goldfuss's name; and it may be argued that, though *R. antiqua* comes before *G. antiqua* in Goldfuss's work, yet the latter, having long ago been referred to *Fenestella*, has the priority in that genus, and ought not to be ousted by another synchronous and indistinct species of the same author. At present, however, there is no proof whatever of the specific identity of *R. antiqua* with *F. arthritica.*

The generic position of our species is not free from doubt. It appears to be an aberrant form of *Fenestella* with an unusually high blade-like keel, but this keel seems so remarkable as to suggest it may be a passage-form into some more elaborated genus. In thin sections it has the appearance of a transparent wall definitely bisecting the substance of the branches, and there is a possibility that in none of the specimens its true summit has been preserved.

I have had some difficulty in identifying the various prepared sections, though I believe that all those figured belong to this species. One specimen, however, is perplexing and perhaps doubtful. This is a shallow, flabellate frond (Pl. XIX, fig. 10), giving a beautiful natural section along the branch, and it seems to show that the central keel, when perfect, was somewhat expanded at the top.

*Affinities.*—This species seems very well characterised, and quite distinct from any of the others that occur at Lummaton.

From the common *F. fanata* it is distinguished by the regular oval shape and uniformity of its fenestrules, by its much coarser dissepiments, and by other features; from *F. subreticularis*, Sandberger, it differs in having larger and less circular fenestrules, less prominent branches, and more numerous cells in each fenestrule.

4. Fenestella, sp. Pl. XX, figs. 3, 3 *a*.

*Description.*—Zoarium small, conical or ovoid, reticulate. Branches exteriorly convex, straight, or slightly undulating, bearing two ranges of large cells, and apparently without a keel. Dissepiments short, straight, nearly as broad as the branches. Fenestrules rather elongate, sub-oval, about one and a half times as long as broad, about twelve in 10 mm. longitudinally, and twenty in 10 mm. horizontally, rather wider than the branches. Cells about four to the length of a fenestrule, with large prominent, lateral, circular mouths opening on the external face.

*Size.*—A small but apparently perfect specimen measures 10 mm. long by 4 mm. wide.

*Locality.*—There is one specimen from Lummaton in the Woodwardian Museum, and another in my Collection.

*Remarks.*—The distinctive characteristic of this fossil is that its cell-openings are on the external side. There seems some ambiguity as to the side on which the cell-openings are in the genus *Fenestella*. Phillips remarks, "the main distinction between this group and *Retepora* is in the position of the pores or cellules, which are internal in *Retepora* and external in *Fenestella*." M'Coy gives the same character. Ulrich, on the other hand, describes the cell-openings as "on the inside (always?)." Hence there seems a decided difference of opinion on this point, and in particular cases of fragmentary or of flabellate specimens it may be very difficult to decide. In the present species, however, the cell-mouths are certainly on the external face, while in the common *F. fanata* they seem to be as clearly on the internal surface, and it also differs from that species in having a finer reticulation, stouter dissepiments, and larger cell-mouths. There is, of course, a possibility that an external guard might have existed, though of this there are no signs in the specimen.

5. Fenestella subrectangularis, *Sandberger*. Pl. XIX, figs. 11, 11 *a*, 12, 12 *a*.

1855. Fenestella subrectangularis, *Sandberger*. Verst. Rhein. Nassau, p. 376, pl. xxxvi, figs. 2—3 *b*.

*Description*.—Zoarium very large, deeply convex and probably infundibuliform, constituted by small, narrow, straight branches, which are very convex on the external or non-poriferous side, divaricate very rarely at ten or fifteen fenestrules, and are united by very numerous broad, low, biconcave dissepiments. Fenestrules short-oval, becoming squarish when worn; at the rate of eleven to 10 mm. in length, and fifteen to 10 mm. in width. Cells in two ranges, alternating, and at the rate to two cells in the length of a fenestrule. External surface smooth.

*Size*.—Height of a large but imperfect frond 65 mm., width 70 mm.

*Locality*.—There is one large (and perhaps one smaller) specimen from Wolborough in Mr. Vicary's Collection; a small specimen in the Torquay Museum, a specimen from Lummaton in my Collection, and a specimen from Lummaton in the British Museum.

*Remarks*.—Mr. Vicary's largest specimen is the half of a deep cone, but it cannot be said whether the cone in this and the other specimens was complete all round. Mr. Vicary's second specimen has larger fenestrules, and the branches divaricate much more frequently, besides which it appears to be flabellate rather than conical, and therefore I am doubtful whether it belongs to the same species as the rest.

This species seems distinguished from the other Lummaton species by its long straight, elevated branches, by its small number of cells, and by the short and small fenestrules, which render it easily recognisable. Its external surface approaches in general appearance the internal surface of *Hemitrypa oculata*, though differing in being decidedly coarser.

An examination of Sandberger's beautiful figures makes me believe that in all probability our present fossil belongs to his species. His figures accurately represent our English specimens in every particular, except that in them the non-poriferous side of the branches is striated instead of being, as in all the English specimens I have observed, smooth. This, however, by itself, could hardly be taken for more than a varietal difference, especially as it might possibly be due to obliteration during fossilisation in our specimens, although they are certainly too well preserved to make this likely. Sandberger, it is true, does not mention the relative number of cells and fenestrules, but a comparison of his figures 2 *a* and 2 *b* give the impression that the former were twice as numerous as the latter.

**2.** *Genus.*—Polypora, *M'Coy*, 1844.

Zoarium differing from that of *Fenestella* by having more numerous rows of cells, and by the absence of any median keel. Silurian to Trias.

1. Polypora populata, n. sp. Pl. XVIII, figs. 2—4; and Pl. XIX, figs. 1, 1 *a*.

? 1827. Gorgonia ripisteria, *Goldfuss*. Petref. Germ., p. 19, pl. vii, figs. 2 *a*, *b*.
? 1841. — — *Phillips*. Pal. Foss., p. 20, pl. xi, fig. 30.
1841. Retepora prisca, *Phillips* (not *Goldfuss*). Ibid., p. 25, pl. xiii, fig. 37.
? 1850. — hexagonum, *F. A. Römer*. Beitr. Harzgeb., pt. 1, p. 6, pl. i, figs. 10 *a*, *b*.

*Description.*—Zoarium large, spreading in an open cup or frond from a massive base. Branches irregular (especially near base), frequently dividing, thick in the centre so as to equal the fenestrules in width; very deep, smooth and steeply bevelled on the external or non-poriferous face, so as to become very narrow at the top, where they are suddenly rounded; rounded on the internal face, and bearing four or five rows of alternating cells; cells set obliquely so as to be lozenge-shaped in the section taken parallel to the branches, and with free elevated rounded distal ends, which give a nodulous appearance to the inner surface, and which appear to have small mouths near their distal extremities. Dissepiments short, indefinite, equal in width to the branches, but rather lower on the external side, and appearing often to be more or less invaded by the cells. Cells about six or seven to the length of a fenestrule. Fenestrules elongate, oval in the centre, polygonal on the external face, similar in size throughout the zoarium, numbering about four fenestrules to 10 mm. in length, and seven to 10 mm. in width.

*Size.*—A large but imperfect specimen measures about 55 mm. from the base to the upper margin of the frond, and about 40 mm. across.

*Locality.*—Lummaton. About seventeen specimens are in my Collection; two very fine examples, probably from the same place, in the Torquay Museum; and others in the Woodwardian. Phillips's figured specimen is in the British Museum.

*Remarks.*—My friend Dr. Gregory regards this species as an aberrant form of *Polypora* rather than a *Phyllopora*. It appears to be composed of true but irregular branches, instead of being an homogeneous perforated network; though the short broad dissepiments, which are rather lower than the branches, seem to be more or less occupied or invaded by cells, while the mode of the increase of the

branches is peculiar, frequently being not by the divarication of a branch, but by the addition of a new branch on the top of a fenestrule, in which case no dissepiment occurs. Hence this species seems to stand midway between the types of the two genera, and perhaps intimates that there is no true reason for the existence of King's genus *Phyllopora*.

It is rare that specimens preserve the minor structure, but in the largest specimen in the Torquay Museum (Pl. XVIII, fig. 2) the arrangement and shape of the cells seems to be in a fair state of natural preservation, and to exhibit the above-mentioned features, while transparent sections made from some of my specimens seem to show that the free part of the cells formed a kind of saw-edge (in section), truncated above by the minute, thickened, circular foramina; and a small specimen, which was destroyed for the purpose of obtaining transparent sections, retained one orifice which seemed to be perfect and to consist of a raised circular foramen parallel to the branch.

The second of the two specimens in the Torquay Museum seems very different in its mode of growth from the rest. It has decidedly smaller and squarer fenestrules, arranged in oblique rows instead of along radiating branches, and numbering five fenestrules to 10 mm. either way across the diagonals, and seven to 10 mm. either way across the sides of the squares. Thus it closely resembles the specimen from Mudstone Bay in the Museum of Practical Geology which was figured by Phillips[1] as *Gorgonia ripisteria*, Goldfuss,[2] except that its fenestration is much smaller. Having carefully examined Phillips's fossil, I am strongly under the impression that it is only an example of the present species, masked by the squeezing and consequent sheering of the matrix, which has drawn out the fenestrules into a lozenge-shape and confused them with the dissepiments. The fenestrules are really little if at all larger than is usual in the Lummaton specimens, Phillips's figure being slightly magnified and in other respects not very accurate. In neither of these two specimens can I see any real signs of cells or foramina, so that we can only presumptively identify them at present. The original *G. ripisteria* of Goldfuss resembles it in general form as far as may be judged from his figure; but, as he describes the non-poriferous face to be strongly striated, we may conclude that his Carboniferous fossil is at least specifically distinct.

It may be observed that, though our specimens show the form to have been more or less infundibuliform, they do not show whether it was regularly cup-shaped or more inclined to be frondescent.

The original specimen from Barton, described by Phillips as *Retepora prisca*,[3] Goldfuss, is in the Lee Collection of the British Museum, and undoubtedly belongs

[1] 1841, Phillips, 'Pal. Foss.,' p. 20, pl. xi, figs. 30 *a*, *b*.

[2] 1827, Goldfuss, 'Petref. Germ.,' vol. i, p. 19, pl. vii, figs. 2 *a*, *b*.

[3] Ibid., vol. i, p. 103, pl. xxxvi, figs. 19 *a*, *b*, *c*.

to this species. It does not show the cell-structure, and Phillips evidently made his identification only from the general shape of the frond and the fenestrules. Our specimens prove that it is really totally distinct from the true *R. prisca*, Goldfuss, which has two undulating rows of cells and broad totally non-poriferous dissepiments, and which appears to belong to the genus *Lyropora*.

Very many years ago I sent two of my specimens to the late Mr. Shrubsole. He labelled one of them "*Retepora prisca*, Phillips, now referred to *Phyllopora*, King," and another "*Phyllopora*, King, figured as *Gorgonia ripisteria* by Phillips."

*Affinities.*—The elevation and freeness of the cells distinguish it from any species with which I am acquainted.

F. A. Römer identifies his *Retepora hexagona* from the Calceola-beds of Brilon with Phillips's *G. ripisteria*. In macroscopic features it looks just like our Lummaton species and is doubtless nearly allied; but, as Römer gives no information as to its cell-structure, it is impossible to say whether it is specifically identical; possibly it may be distinguished by the more definitely hexagonal shape of its fenestrules, though this character cannot be of much importance, as it depends on their incidental arrangement.

*F. Bischoffii*, F. A. Römer,[1] has a slighter network and a few scattered pustules on the reverse side. As given by Giebel[2] it is more similar; but, no cells being shown or indicated by the latter author, it is impossible to identify it from his description.

Of the American species figured by Ulrich the only one which at all resembles it is *P. Shumardi*, Prout,[3] but that is easily distinguished by the much greater width of the branches than of the fenestrules, and by the smaller number of cells to a fenestrule.

A specimen of *P. papillata*, M'Coy,[4] in the British Museum is very similar in macroscopic characters though decidedly smaller, and in one part shows an excentric arrangement like the Torquay specimen mentioned above. As described by M'Coy, however, it is quite distinct from this species.

2. Polypora pagana, n. sp. Plate XVIII, figs. 5, 5 *a*.

*Description.*—Frond spreading. Branches undulating, about two-thirds the width of the fenestrules, sub-circular in section. Fenestrules about five to the length of 10 mm., and eight to the width of 10 mm., irregularly oval. Dissepi-

[1] 1855, F. A. Römer, 'Beitr. Harz.,' vol. iii, p. 2, pl. i, figs. 1 *a*, *b*.
[2] 1858, Giebel, 'Sil. Fauna Unterharz.,' p. 55, pl. vi, fig. 13.
[3] 1890, Ulrich, 'Geol. Surv. Illin.,' vol. viii, p. 586, pl. lv, figs. 2—2 *d*.
[4] 1844, M'Coy, 'Syn. Carb. Foss. Ireland,' p. 206, pl. xxix, fig. 10.

ments very short, similar in width to the branches, but lower and flatter. Cells more or less regularly alternating in three or four rows, about eight or nine to the length of the fenestrule, with circular and apparently slightly elevated mouths.

*Size* of a fragment, 12 mm. by 14 mm.

*Locality.*—Lummaton. One or two specimens in my Collection, and two doubtful specimens in the British Museum.

*Remarks.*—Several of my specimens seem to group themselves together in presenting rather a different macroscopic appearance from the preceding species, but in only one of these have I been able to find traces of the cell-structure, while the other characters are too indefinite to found any distinction upon them. Even in the case of the last-named specimen it may be questioned how far its features may be due to its state of preservation. Still it certainly does bear a very different appearance, and it may perhaps be separated by the following characters: —the upper part of the cells are much less free, the mouths simply rising in a kind of crater from the branch, the number of the rows of cells seem to be decidedly fewer, the branches are more undulating, and the network is generally, though not always, a good deal smaller.

*Affinities.*—None of the numerous American forms described by Ulrich seem to bear much resemblance to this species, the nearest being *P. submarginata*, Meek,[1] which has more numerous ranges of cells, and *P. gracilis*, Prout,[2] which has very long lanceolate fenestrules.

### 3. *Genus.*—Hemitrypa, *Phillips*, 1841.

Zoarium rigid, undulating, or infundibuliform. Apertures of the zoœcia in two ranges separated by a keel, which at regular intervals is elevated into small pillars bearing a superstructure or guard. Guard lying parallel to the celluliferous frond, and forming a regular network with small round or hexagonal openings, corresponding in number and position to the zoœcial apertures beneath them, and constituted by straight or zigzag bars, one series corresponding to the branches and supported by the carinal pillars, and a second series, usually somewhat thinner, suspended midway between and united to the former by similarly placed transverse processes. (Silurian to Carboniferous.)

[1] 1871, Meek, 'Pal. Eastern Nebr.,' p. 154, pl. vii, figs. 7 *a*, *b*; and Ulrich, 'Geol. Surv. Illin.,' vol. viii, p. 602, pl. lxi, figs. 6—6 *b*.

[2] 1860, Prout, 'Trans. St. Louis Acad. Sci.,' vol. i, p. 580; and 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 590, pl. lxi, figs. 10, 10 *a*.

This genus was established by Phillips, without definition, for the well-known Devonshire fossil, which he clearly indicates and figures, though not very accurately describes.

In 1844 a second species, *H. hibernica*, was described by M'Coy[1] from the Carboniferous Rocks.

Mr. G. W. Shrubsole,[2] however (followed by Mr. S. R. Vine), disallowed the genus, interpreting it as simply a *Fenestella* clothed with a coral which he asserted to be also parasitic on Brachiopods and Crinoids. This statement threw the genus into disrepute among European palæontologists, and caused it to be omitted from such books as Zittel's 'Handbuch' and Nicholson's 'Palæontology.' The Americans, however, do not seem ever to have been misled. Various species have been described by Hall and others; and Ulrich[3] in 1890 strongly combated Shrubsole's views and conclusively proved the validity of the genus and the unity of its structure. He mentions at least fourteen different species belonging to it.

More lately, in 1893, Prof. Cole[4] published a detailed description of the structure of *H. hibernica*, M'Coy, in which he clearly showed that the Irish species, like the American, was a single organism, and that the parasitic hypothesis was entirely at variance with facts. The same will be seen to be the case with the type species of the genus described below. It is utterly impossible on the examination of sections to doubt that it is more than a single complicated *Polyzoon*, and, indeed, even rough natural specimens from Lummation could hardly fail to lead an observer to the same conclusion: the accurate adjustment of the upper and the inner sides could not be imagined to be the result of parasitic growth, even if the organic connection between them were not as clearly seen as it is in microscopic sections. Moreover, as Ulrich has well pointed out, the outer network has not a closed floor as must have been the case had it been a parasite. Possibly Shrubsole might have been misled by an inaccuracy in this respect in Phillips's description, alleging that the fenestrules were closed externally before reaching the guard, which is certainly not the case.

[1] 1844, M'Coy, 'Carb. Foss. Ireland,' p. 205, pl. xxix, fig. 7.

[2] 1879, Shrubsole, 'Quart. Journ. Geol. Soc.,' vol. xxxv, p. 282.

[3] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 353.

[4] 1893, G. A. J. Cole, 'Sci. Proc. Royal Dublin Soc.,' vol. viii (n. s.), p. 132, pl. viii, figs. 1—5.

1. Hemitrypa oculata, *Phillips*. Pl. XIX, figs. 13—20.

1841. Hemitrypa oculata, *Phillips*. Pal. Foss., p. 27, pl. xiii, figs. 38 *a—e*.
1848. — — *Bronn*. Handbuch, vol. i, p. 586.
1849. — — *d'Orbigny*. Prodrome, vol. i, p. 101.
1855. — — *Sandberger*. Verst. Rhein. Nassau, p. 379, pl. xxxvi, figs. 6, 6 *a*.

*Description*.—Zoarium sometimes rather large, irregularly infundibuliform, generally steeply conical at first and then sometimes expanding in an irregular cup, and composed of a framework of branches and dissepiments surrounded by an external guard. Apex or point of probable attachment minute. Branches slender, straight, spheroidal in section, covered on the inward or reverse side with three or four coarse longitudinal striæ, and divaricating rarely, *i. e.* about once in eight or ten fenestrules. Dissepiments slight, long, straight, narrow, non-poriferous, forming nearly square, angular fenestrules, which are considerably wider than the branches. Cells arranged in one closely alternating zigzag row, with mouths opening on the outward face of the branch, alternately on each side of its median line; the cells thus seeming to be few, and to be situated one at the base of each pillar. Pillars thin, rising perpendicularly to the branches, at about the rate of three to the length of a fenestrule, and about equal in height to the width of the fenestrules, supporting a guard or external framework. Guard consisting of a regular network of circular apertures, formed by the union of longitudinal and transverse bars. "Principal bars" exactly over and parallel to the branches, and supported by the pillars, and having midway between them a second series of rather smaller "secondary longitudinal bars," which are supported by transverse bars or scalæ, so that the longitudinal and transverse bars are equally numerous in a given square area.

*Size*.—Some of my specimens exceed 35 mm. in diameter, but none of them are perfect.

*Locality*.—Lummaton. Numerous specimens are in my Collection and in the British and other Museums.

*Remarks*.—This elegant little fossil is decidedly common, and is very easily recognised. From the accompanying species of *Fenestella* it is distinguished at once by the smallness of its reticulation, its slight branches, and its regular short oblong fenestrules, as well as by its guard, which is totally unlike any other organism occurring at Lummaton. The arrangement of the cells also appears to be distinctive, as they seem to lie rather in a single alternating row than in a double row, so that the cross-section of the branch generally shows a single cell with the mouth opening on one side or the other, instead of two cells side by side divided by a median wall. At the same time the rows are not absolutely single, as the cells do

occasionally become paired, especially at the dissepiments. The branches seem to be higher than wide, and the cell-mouths are on their outer surface, on one side or the other of the median row of pillars. There seem to be about three pillars and five cells to the length of a fenestrule.

Though Phillips gives "Barton" as the only locality, his figured type in the Museum of Practical Geology is from Hope's Nose. Its reticulation is coarser than usual in Lummaton specimens, and its bars may be rather stronger, but I see no reason for supposing it to be distinct. In any case the Barton fossils have a right to Phillips's name.

The myth that *Hemitrypa* is a *Fenestella* clothed with a parasite may be considered utterly exploded, and Phillips's original diagnosis (with the exception of the one inaccuracy, involved unfortunately in the meaning of its name) established. The guard in *Hemitrypa* is no more parasitic than is the horn of an ox or the tail of a bird. The function, however, of this guard is not very evident. It might be that its purpose was to keep off every substance except food from the delicate tentacles of the animal. But if this were so, it might be asked how it is that both in the Devonian and Carboniferous we find the ordinary unprotected *Fenestella* dominating. To this question an answer might perhaps have been found in the soft parts of the animals had they been preserved. Or again, its purpose may have been to give strength to the slight expanding funnel which the zoarium forms. Without it an organism of such a shape would be peculiarly liable to destruction, whereas the arrangement of pillars and beams must have rendered it decidedly strong. Judging from the general facies of the Lummaton fauna, it did not inhabit deep water, and was exposed to the action of strong currents and tides, and, if so, the benefit of such supports can be easily understood.

*Affinities.—H. hibernica*, M'Coy,[1] differs in its zoarium forming a very much larger, more regular and acute cone, and in its fenestrules being decidedly longer while measuring the same in width. Its cells also seem to be arranged in a more definitely double row. Cole has shown that its reverse face agrees in being striated in the young state, and that the meshes of its guard or tegmen are circular and not hexagonal as described by M'Coy.

The various American species described by Ulrich are all distinguished by having two distinct ranges of cells in the branches.

### 4. *Genus.*—Isotrypa, *Hall*, 1885.

Ulrich thus defines this genus :—"Zoaria infundibuliform. Branches connected by dissepiments. Keel at first very thin, then abruptly expanded; at intervals,

[1] 1844, M'Coy, 'Syn. Carb. Foss. Ireland,' p. 205, pl. xxix, fig. 7; and 1893, Cole, 'Sci. Proc. Roy. Dublin Soc.,' vol. viii, n. s., p. 132, pl. viii, figs. 1—5.

corresponding to the true dissepiments, the thickened summits are connected by strong processes, giving to the superstructure an appearance very much like that of the reverse face of the frond. Zoœcia in two ranges."

Though I have referred the following species to this genus as being that to which it seems most nearly to approach, it hardly seems to me that it can come within its limits, and I should be more inclined to refer it to a new genus with the following definition :—" Zoaria infundibuliform. Branches connected with dissepiments. Keel at first thin, then gradually expanding, and bearing on its summit strong bars which contain double rows of supplementary cells and are united by occasional scalæ. Zoœcia in two intermittent ranges. Intervals filled with vesicular tissue." Suggested name, "*Amorphotrypa*."

1. Isotrypa ? Gregorii, n. sp. Pl. XX, figs. 1—2 *e*.

*Description.*—Zoarium deeply conical or funicular, rising from a thick massive base of attachment, and consisting of a double framework filled with coarse vesicular tissue. Inner or zoœcial framework formed of straight, narrow, convex branches, smooth and non-poriferous on the inward face, and swelling at the dissepiments, which are straight and level or continuous, so that the short oblong fenestrules do not alternate, but are arranged in level rows. Branches bearing along their outward side lengthways a series of lofty monticules, which appear to be placed at the insertion of the dissepiments, and which contain two large cells divided by a thin central partition or knife-edge, which rises together with the contracted walls for about a length equal to the cells through the vesicular tissue to the outer framework, which consists of broad longitudinal beams, bluntly triangular externally, corresponding to the branches, and apparently containing on their inward side small cells or triangular pustules at the rate of four to a dissepiment; these beams being perhaps joined to each other by intermediate dissepiments or dense tissue.

*Size.*—A small specimen measures 20 mm. in height, and 10 mm. in diameter across the top.

*Locality.*—Lummaton. There are three specimens in my Collection, one of which has been used for making sections.

*Remarks.*—This is a decidedly puzzling fossil. After a very careful examination Dr. Gregory and myself came to the conclusion that of the genera given by Ulrich it most probably agrees with *Isotrypa*. At the same time there are several points which render it very doubtful whether it can properly be referred to that genus, and a subsequent examination very much inclines me to the opinion that, unless it can be referred to *Fenestrapora*, a new genus must be founded for it, as suggested above (*Amorphotrypa*).

Unfortunately the material at our command has been too scanty to enable us to get very clear sections, and it is only by a very careful examination that the relations of the different parts of the structure can be made out as far as it has been done.

*Affinities.*—I find nothing at all like it in Ulrich's work.

*Fenestella conica*, F. A. Römer,[1] seems to be just like its reverse face, but Römer describes both sides of his fossil as similar.

## II. *Family.*—Acanthocladiidæ, *Zittel*, 1880.

This family is distinguished from the preceding by its mode of growth, being formed of strong central stems and lateral branches, which may be free or may combine with each other to form fenestrules, but have no non-poriferous dissepiments, its form being thus dendroid, pinnate, or fenestrated.

### 1. *Genus.*—Diplopora, *Young and Young*, 1876.[2]

"Zoaria consisting of very slender straight stems, which throw off a few lateral branches of equal dimensions. Cells in two rows. Median keel moderately developed." Ulrich[3] thus defines the genus, which he separates from *Pinnatopora* (*Glauconome*) as wanting pinnæ. The species hitherto described are from the Carboniferous Rocks.

1. Diplopora pristina, n. sp., Pl. XX, fig. 4.

*Description.*—Zoarium consisting of very slender, subcylindrical, slightly curved branches, about ·5 mm. in diameter, deeper than wide. Obverse side with a double row of alternating apertures situated along the margins, to which thin prominent peristomes give a slightly wavy outline. Apertures subcircular or oval, opening obliquely outwards, with elevated peristomes, about ·1 mm. in diameter, twice their distance apart, and with five apertures to 2 mm. Keel elevated above the apertures, bluntly angular, gently tuberculate.

[1] 1850, F. A. Römer, 'Beitr. Harz.,' pt. 1, p. 7, pl. i, figs. 13 *a*, *b*.

[2] Schafhäutl applied the name to an *alga* in 1863, but it does not seem, therefore, necessary to change Young and Young's appellation, since the latest rules of nomenclature do not enforce changes on account of a word being already used in the Vegetable Kingdom ('Bull. Soc. Zool. Fr.' for 1890, p. 38).

[3] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 398.

*Size.*—A fragment containing six or seven cells measures 3 mm. in length and is ·5 mm. in width.

*Locality.*—A single specimen from Lummaton is in my Collection.

*Remarks.*—This species is only known to me by a single fragment, which does not show any branching. In spite of its small dimensions it seemed impossible to identify it with any of the accompanying *Fenestellidæ*, both on account of its general style and because there are no signs of any dissepiments, although a considerable number of cells are seen. I was interested, therefore, to find an almost identical fossil figured by Ulrich from the Lower Coal-measures of Illinois, especially as his fossils showed the character of the branching and the striation of the reverse side. There seems to be little doubt that these fossils are generically identical, and hence, though some details are wanting for a complete description of our species, I have no hesitation in giving it a specific name.

*Affinities.*—This species, while coming very close to *D. biserialis*, Ulrich,[1] differs in a few particulars. The apertures seem rather larger, less numerous, and less marginal, and the keel is perhaps rather more prominent, and shows decided signs of occasional slight prominences.

*D. marginalis*, Young and Young,[2] is described as having a thin tuberculated central keel, but it is also said to have two supplemental lateral keels.

## 2. *Genus.*—Septopora, *Prout*, 1859.

Zoarium flabellate, with numerous primary branches, increasing by bifurcation or interpolation, and so arranged that the smaller secondary branches unite with those of adjacent stems. Reverse side usually finely striated, and bearing scattered dimorphic pores; celluliferous side with two rows of zoœcia. Apertures large. Devonian and Carboniferous.

### 1. Septopora? sp. Pl. XX, figs. 5, 5 *a*.

*Description.*—Zoarium flabellate, consisting of an irregular network formed by several primary branches radiating from a common centre or base, from the sides of most of which sub-parallel secondary branches proceed at an angle of about 30°, generally decreasing in size according to their distance from the base, the earlier secondary branches being nearly as large as the primary. Secondary

[1] Ibid., vol. viii, p. 637, pl. lxii, figs. 11—11 *c*.

[2] 1876, Young and Young, 'Proc. Nat. Hist. Soc. Glasgow,' vol. ii, pt. 2, p. 326, pl. iii, figs. 14—21.

branches approximately parallel, and united with each other by numerous short lateral branchlets, which sometimes seem free, sometimes meet at an angle, and sometimes are so short and straight as to have the character of simple dissepiments, nearly equal to the secondary branches in size and forming elongate irregular fenestrules between 1 and 2 mm. in length, from the summits of which new branches occasionally arise; the network becoming more lax and disconnected near the margins. Intimate structure unknown.

*Size.*—A defective specimen is 30 mm. long, and 20 mm. wide.

*Locality.*—A single specimen is in the Torquay Museum. Its locality is unknown, but its matrix is very similar to the limestones of Lummaton or Wolborough.

*Remarks.*—The face of this fossil being worn, it is impossible to discover any structural characters, but from its close resemblance to some American forms there seems no reason to doubt that it belongs to the genus *Septopora*. The fenestrules appear to be really formed by amalgamated branchlets, and sometimes, especially near the margins, these become very irregular, though occasionally the lateral bars are so short and straight (as in the figured portion) that there is nothing to distinguish them from dissepiments.

It could not be assigned to the genus *Ptilopora*, because its primary branches are numerous and its fenestration much less regular.

*Affinities.*—From *Septopora biserialis*, Swallow, var. *nervata*, Ulrich,[1] it differs in having the secondary branches set at a greater angle, and in having larger and more elongate fenestrules. From *S. pinnata*, Ulrich,[2] it differs in its more complete, regular, and elongate fenestration, and in the diminishing character of its secondary branches, but it certainly nearly approximates to the latter species.

### 3. *Genus.*—Ptilopora, *M'Coy*, 1844.

Zoarium pinnate, the median branch stronger than the oblique lateral branches. Lateral branches united by frequent non-poriferous dissepiments. Zoœcia in two rows.

1. Ptilopora (?), sp. Pl. XX, fig. 6.

*Description.*—Zoarium pinnate, with a long cylindrical central stem. Side branches small, set at a very wide angle to the central stem, and united by very broad dissepiments, which thus appear to form short oval irregular fenestrules.

[1] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 632, pl. 64, fig. 6.

[2] Ibid., vol. viii, p. 633, pl. lxiv, fig. 7; and pl. lxv, figs. 1, 1*a*.

*Size.*—Length of fragment 14 mm., width of central stem 1 mm., length of fenestrules 1 mm.

*Locality.*—Lummaton. A defective specimen is in Mr. Champernowne's Collection.

*Remarks.*—This specimen, though too imperfect for specific (or perhaps generic) determination, seemed worth recording, as its large size, its stem, and the remains of its ramification point to its being the remnant of some form otherwise unknown in these beds. No structure is observable, the lower or perfect part of the stem being dense. This part has the appearance of having been free, but a closer examination seems to show that lateral branches start from its lower side, though they are hidden by the matrix.

Dr. Gregory, on examining it, suggested that it might be the "broken-down base of a species of *Ptilopora*," though remarking that "possibly it might prove something very different, as, for instance, the remains of a *Gorgonia*." Further examination inclines me more and more to the former supposition. It must, however, be left doubtful until better specimens are found.

### 4. *Genus.*—Penniretipora, *d'Orbigny*, 1849.[1]

Zoarium small, delicate. Lateral branches short, free. Cells in two rows, which are divided by a median keel, which is fainter or wanting on the lateral branches.

1. Penniretipora (?), sp. Pl. XX, figs. 7, 7 *a*, 8, 8 *a*, 10, 10 *a*.

*Description.*—Zoarium consisting of a central stem about ·5 mm. in width, decreasing very slowly, and giving out alternating branches from each side at an angle of about 60°, which are at first much smaller than the principal stem, but which sometimes (at least) expand, and in turn bear smaller branches. Cells arranged in two alternating ranges (on the main stem). Secondary branches about 1 mm. apart, with several sharp longitudinal ridges on one side. Reverse surface of main stem minutely punctate.

*Size.*—A fragmentary specimen measures about 10 mm.

*Locality.*—One specimen in the Woodwardian Museum, and three in my Collection, are from Lummaton.

[1] 1849, d'Orbigny, 'Prod.,' vol. i, p. 45.

*Remarks.*—It is exceedingly hard to say whether these interesting but indistinct little fossils all belong to one species or, on the other hand, whether they are merely fragments of fossils which, if fully preserved, would present a different aspect. It seems the simplest plan in the present state of our knowledge to record them by themselves under one heading, without attempting to decide the species or even their genus further than to say that Dr. Gregory considered them more likely to belong to *Penniretipora* than to anything else, and that to that opinion I am inclined to bow.

2. Penniretipora, sp.

*Description.*— Stalk rather thick, with occasional alternating secondary branches, which seem generally very short and rounded, but are occasionally longer. Eight branches in 10 mm.

*Size.*—A fragmentary specimen measures 8 mm. long.

*Locality.*—Lummaton. There is one specimen in my Collection.

*Remarks.*—This obscure fragment seems in shape like a *Penniretipora*, but the arrangement of its pores is unknown. Its peculiarity is the rounded form of its branchlets.

**5.** *Genus.*—Ramipora, *Toula*, 1875.

Mr. R. Etheridge, jun.,[1] states that Dr. Toula[2] separated a *Synocladia*-like polyzoon, in which a main stem gives off large branches at the same level on opposite sides, trending upward, and themselves giving rise to shorter and slighter dissepiments on each side, which meet each other and form arched fenestrules. The stem and branches are keeled on each face, and the cells open only on one side, and form longitudinal rows.

Mr. Etheridge[3] further remarks that the genus is distinguished from *Synocladia* by (1) the absence of dichotomization of the stem and primary branches; (2) the presence of bilateral symmetry; (3) the cells all opening on the same plane on each side of the median keel instead of being divided by several longitudinal carinæ; (4) being keeled on both faces; (5) the dissepiments not being *all* regularly celluliferous.

One species only has been described from the Permo-Carboniferous rocks of Spitzbergen, and a variety of it from the Caradoc of Wales.

[1] 1878, R. Etheridge, jun., 'Quart. Journ. Geol. Soc.,' vol. xxxiv, p. 625.

[2] 1875, Toula, 'Neues Jahrb. f. Min.,' p. 230, pl. x, figs. 1 *a*, *b*.

[3] 1879, R. Etheridge, jun., 'Geol. Mag.,' dec. 2, vol. vi, p. 241, pl. vi, figs. 1—3.

1. Ramipora, sp. Pl. XX, figs. 9, 9 *a*, 11, 11 *a*.

*Description.*—Zoarium plumose, consisting of several main slightly arching stems, arising from a parasitic base, and giving off at intervals of about 1·5 mm. level secondary branches, trending upwards at an angle of 50°. Secondary branches of each stem joined by a few slighter dissepiments to each other or to those of adjacent stems. Cells with contracted mouths, arranged in a double row, opening outwards, and existing not only on the stems but on the secondary branches and dissepiments.

*Size.*—A fragmentary specimen measures 18 mm. by 20 mm.

*Locality.*—There are two fine specimens in the Torquay Museum, which are probably from Lummaton, another in the Woodwardian Museum, and a fourth in my Collection from the same place.

*Remarks.*—Dr. Gregory considers that these fossils evidently belong to the genus *Ramipora*, and on his authority I place them here, though some points still require elucidation. They differ from the only described species, *R. Hochstetteri*, Toula, and its variety *carinata*, Etheridge, by their slighter forms, much smaller size, and the comparatively less developed character of the fenestrules. Their branches are not quite so constantly level, the dissepiments seem rarer, and the cells are arranged simply in two straight ranges on the main branch, quite unlike Toula's figured type.

It is certainly to be observed that my sliced specimen does not absolutely coincide with the others with which I have united it on Dr. Gregory's authority, and that none of the specimens give any indications of a keel, which possibly may be accounted for by the state of their fossilization.

## 2. Sub-order.—TREPOSTOMATA, *Ulrich*, 1890.

### I. *Family.*—Batostomellidæ, *Ulrich*, 1890.

#### 1. *Genus.*—Batostomella, *Ulrich*, 1882.

Zoarium ramose, slender, without monticules. Zoœcia thick-walled near surface, with delicate distant diaphragms. Apertures small, oval or circular. Interspaces rounded, thick, spinulose. Acanthopores small, usually numerous. Mesopores small, subcircular.

1. Batostomella oomorpha, n. sp. Pl. XX, figs. 12, 12 *a*, 13, 13 *a*.

*Description.*—Zoarium small, elongate (irregularly cylindrical?), showing in a tangential section numerous oval or petalloid zoœcia about ·2 mm. in diameter, with rather thick walls, more or less entirely isolated by numerous small subangular mesopores, and occasional acanthopores. Zoœcial tubes apparently (as seen in a natural axial section) very long, subcylindrical, arching, and constricted near the surface.

*Size of Fragment.*—Length 7 mm., width 1·5 mm.

*Locality.*—Lummaton. Two fragmentary specimens are in my Collection.

*Remarks.*—These two small specimens have proved very perplexing; and at last I have concluded that they probably belong to the same species. One of them is a transparent section which seems to show the tangential structure very clearly. The zoœcia are normally oval, but appear to be rendered occasionally petaloid by the existence of lateral acanthopores. The mesopores vary considerably in size, and would seem from their occasional opacity to possess frequent diaphragms.

The other specimen is a natural section along the axis, and shows indistinctly very long tubes which arch out gently from the axis. It is by no means certain that it belongs to the same species.

I was at first inclined to regard this as a species of *Callopora*, comparing it with *C. subnodosa*, Ulrich,[1] to which it seemed very similar; but further examination revealed the evident presence of acanthopores, and therefore shut it out of this genus. On the other hand, a further comparison of the two specimens with the various species of *Batostomella* given by Ulrich seemed to show so many common features that I think it may with sufficient probability be provisionally referred to that genus, although the mesopores seem on the whole larger than appears to be the case in any of Ulrich's figured species. It is certainly unfortunate that I have been unable to procure a transverse section. As the specimens show some beautiful detail, and seem unlike anything I know, I venture to suggest the specific name.

[1] 1890, Ulrich, 'Geol. Surv. Illinois,' vol. viii, p. 417, pl. xxxiii, figs. 5—5 *c*.

## ECHINODERMATA, *Klein*, 1734.

### 1. Class.—CRINOIDEA, *Miller*, 1821.

#### 1. Order.—CAMERATA, *Wachsmuth* and *Springer*, 1885.

"Brachials, and often interbrachials, included to a varying extent in the dorsal cup, and ambulacrals of the same included in the tegmen, all these plates being immoveably united by close suture; anal interradials usually distinct; arms pinnulate; no axial canal."

The above definition is given by Mr. F. A. Bather, to whose kind help in the following pages I am very much indebted, and whose system of nomenclature I have mainly followed.

#### I. *Family*.—Hexacrinidæ, *Wachsmuth* and *Springer*, 1885.

##### 1. *Genus*.—Hexacrinus, *Austin*, 1843.

Dorsal cup conical or subglobose, sculptured or nodose, with bilateral symmetry. Basals three, viz. one small in interradius and two large, though they may approximate in size. Radials five, very large, excavate above. Primibrachs of 1 to 4 rows, minute, not generally filling the excavation, which includes the first axillary, which forms the base of two free arm-branches to each ray. Anal plate narrower than the radials, in line with them, and supporting two or three plates. Upper margins of adjacent radials usually supporting a pronounced interradial plate of the tegmen. Tegmen somewhat raised, composed of polygonal tuberculated plates. Anus subcentral or lateral, forming a simple opening, or supported by a small tube composed of small polygonal pieces. Column cylindrical; some columnals larger, nodose or sculptured, all with radiated articular faces and a small, circular, central canal.

1. Hexacrinus interscapularis, *Phillips*, sp. Pl. XXI, figs. 1—4; and Pl. XXII, figs. 1—2 *a*.

1841. Platycrinus interscapularis, *Phillips*. Pal. Foss., p. 28, pl. xiv, fig. 39.
1843. — — *Austin*. Ann. Mag. Nat. Hist., vol. x, p. 109.
1843. Hexacrinus melo, *Austin*. Recent and Fossil Crinoids, p. 48, pl. vi, figs. 1 *a—e*.
1843. — depressus, *Austin*. Ibid., p. 49, pl. vi, figs. 2 *a—e*.
1881. — interscapularis, *Wachsmuth and Springer*. Proc. Acad. N. S. Philad., p. 254.
1889. — — *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup sometimes very large, short, globose, transversely oval with diameter about 6·5. Attachment of column very small. Basal circlet rather large, very flatly cup-shaped, hexagonal, wider than broad, composed of three large subequal hexagonal basals (one of which is sometimes smaller than the others). Radials five, very large, flat, and perpendicular, resting on five of the six sides of the basal circlet, frequently wider than high, rather unequal in size and shape, roughly hexagonal, straight below, excavate above. Anal plate resting on the two basals, pentagonal, rather higher than wide, and nearly equal in size to the adjacent radials. Arms set horizontally, dividing into pairs almost immediately, rounded and with narrow brachials. First primibrachs very small, triangular, fitting into but not filling the excavations in the radials. Second primibrachs very small and linear. Third primibrachs equally small, axillary.

Tegmen capacious, sometimes flattish, sometimes almost as convex as the dorsal cup, composed of numerous polyhedral plates.

Ornamentation of plates minute, consisting of crowded little close-set warts or tubercles, connected with each other by four or five minute rays and usually irregularly scattered over the whole surface, but sometimes having a tendency to run into a concentric or a radiating order or sometimes vanishing on portions of the surface.

*Size of Calyx.*—The type specimen is 45 mm. in height, 45 mm. in breadth, and 35 in width. Mr. Vicary's largest specimen is about 55 mm. in height, 55 mm. in breadth, and 45 mm. in width.

*Localities.*—This is by far the commonest Crinoid of these beds. From Wolborough there are eighteen specimens in Mr. Vicary's collection, fifteen in the Torquay Museum, several in the British Museum, nine in the Museum of Practical Geology, one in Mr. Champernowne's Collection, and one in mine. From Lummaton there are eleven specimens in my Collection, and probably ten in the Torquay Museum.

*Remarks.*—One of the specimens in the Museum of Practical Geology is Phillips's type, and the same specimen has also been figured by Austin under the name of *Hexacrinus melo;* Austin refers to Phillips's species as identical, but gives no reason for changing the name.

*Hexacrinus depressus,* Austin, also appears to be synonymous, as pointed out by Schultze.[1] It differs chiefly in having a flattish tegmen composed of smaller plates than those in the type specimen; but the examination of a number of examples shows that the tegmen varies very much in elevation, and that Schultze is right in asserting that this character has no specific value. This variety is not uncommon; at least two of Mr. Vicary's fossils, and five of those in the Museum of Practical Geology, belong to it.

The typical arrangement of the tegmen appears to be as follows:—(1) a central plate bearing an elevated central protuberance or boss, which according to Wachsmuth and Springer is the posterior oral plate, and is surrounded by (2) a cycle of seven almost equal polygonal plates, consisting of the four other oral or proximal plates, two intercalated anals, and an odd plate of the anal system; (3) interambulacrals in two or three ranges, viz. a first row of three plates resting on the first primary radials, a second row of two plates, and a third row (not always present) of one plate; (4) between each insertion of the arms and the proximal cycle rows of two covering plates decreasing outwards; (5) over the anal plate, three rows of plates, two in each row.

The ornamentation of the species is rather variable, though always bearing the same general character of minute pustules giving a roughened appearance to the surface to the naked eye. In one of Mr. Vicary's specimens the ornament is very much finer and more confluent, and in the type it is coarser and less universal than usual.

One of the Torquay specimens from Lummaton has the distal margins of the basals bordered by a row of small tubercles distinctly larger than the rest, and the proximal border of the radials seems ornamented in the same way.

The suture-lines are usually slight and narrow, especially in the larger fossils, but occasionally they are decidedly deeper and wider. This may, however, be partly due to injury in fossilization.

*Affinities.*—I think that there can be no doubt that the Eifel fossils which Schultze refers to this species are totally distinct from it. They have a larger facet of attachment, more expanded basals, wider radials, and a coarser and entirely different style of ornament. They should therefore resume the name *H. granifer*, F. Römer, sp.[2]

[1] 1867, Schultze, 'Denksch. k. Acad. Wissensch. Wien,' vol. xxvi, p. 191, pl. viii, fig. 5.

[2] 1852, F. Römer, 'Verhandl. d. Naturh. Vereins Rheinl.,' vol. ix, p. 281, pl. ii, fig. 1.

2. Hexacrinus macrotatus, *Austin*. Pl. XXII, figs. 3—8, and Pl. XXV, figs. 1, 1 *a*.

1841. Platycrinus tuberculatus, *Phillips* (not *Miller*, 1821). Pal. Foss., p. 134, pl. lx, fig. 39*.
1843. Hexacrinus macrotatus, *Austin*. Mon. Rec. and Foss. Crin., p. 50, pl. vi, figs. 3 *a—d*.
1849. Platycrinus Phillipsii, *d'Orbigny*. Prodrome, vol. i, p. 103.
1889. Hexacrinus macrotatus, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description*.—Dorsal cup large, rather elongate, obtusely pear-shaped or ovate longitudinally, oval in section with diameters of about 4 : 5.

Attachment of column very large. Basal circlet large, hexagonal, forming a rather shallow cup composed of three hexagonal basal plates, of which two are sometimes larger than the third, and which are short, being nearly twice as wide as high. Radials five, very large, considerably longer than wide, subquadrate or subpentagonal (according as they rest on the centre of a basal or on the sides of two adjacent basals), increasing in width upwards, deeply excavated on the upper margin. Primibrachs confined to a single row, minute, axillary, not filling the excavation. First secundibrachs large, lunate. Anal plate resting on the basals, similar to the radials (between which it is intercalated) but decreasing in width upwards, followed by a smaller square interradial.

Tegmen rather small, flattish, constricted, consisting of a few large central polyhedral plates with some very small plates in the distal region.

Ornamentation coarse and confluent; three or four rows of sharp but confluent nodules on the basals, the first of which forms an intermittent ring round the attachment of the column. Radials with raised bevelled margins, and three or four irregular transverse nodular bands. Suture-lines deep and widely angular.

*Size of Calyx*.—Height 33 mm., width 30 mm., breadth 32 mm.

*Locality*.—Wolborough. There are two specimens in the Museum of Practical Geology, four specimens in Mr. Vicary's Collection, one in the British Museum, and one in my Collection.

*Remarks*.—One of the specimens in the Museum of Practical Geology is clearly the original of Austin's fig. 3 *a*. The other is exceedingly fragmentary; but from the shape of the remaining matrix and from the fact that it shows a single secundibrach it appears in all probability to be the original of Austin's fig. 3 *b*, but injured after drawing, having lost its basal part. As the fossil was evidently fragile, such an accident might easily have occurred. If this be so, it is also in all probability the original of Phillips's Devonian figure of *Pl. tuberculatus*, which, although the matrix is unrepresented, shows the single remaining brachial, and of which he writes, "it has the air of *Pl. tuberculatus*, Miller, but its surface is perhaps only rough by the weathering of the stone; its scapular plates are longer and its pelvis more

conical. Probably it had no interscapular plate." Both the above specimens are very poor and worn, but they evidently belong to the same species; and other better specimens can be identified with them, which show, among other things, that an "interscapular" or anal plate did exist in the species. They evidently do not belong to the species referred to *Pl. tuberculatus* by Phillips[1] in the 'Geology of Yorkshire,' nor, I think, to the true *Pl. tuberculatus*, Miller.[2] The latter appears to be a Carboniferous form, and is very imperfectly described, but seems to differ among other things in its style of ornamentation and its pentagonal basal circlet. It is identified by Wachsmuth and Springer[3] with *Pl. ellipticus*, Phillips,[4] in part, and with *Pl. tuberculatus*, Austin, which seems probably to represent it. Consequently Austin's[5] name, *H. macrotatus*, becomes the name of the species.

The tegmen is well seen in a remarkably fine specimen in the British Museum. It is very much smaller and lower than the dorsal cup. It has a very large polyhedral central or "posterior oral" plate, surrounded by a circle of nine other large plates. Of these the four anterior are pentagonal, and seem to be the other oral plates; the posterior is a massive anal in the shape of a wedge or bird's breast, which rests upon the intercalated anal of the radial circlet; while the circle is completed on each side by two smaller pentagonal plates which may also belong to the anal system. The distal plates are very small in this specimen and too indistinct for description.

*Affinities.*—*H. granifer*, F. Römer[6] (which seems incorrectly identified with *H. interscapularis* by Schultze), differs from this species by having a shorter cup, shallower suture-lines, less confluent ornament, and larger and more numerous interambulacrals. The anal plates are also unlike, consisting of an intercalated anal surmounted by more than a second single plate.

Schultze[7] doubtfully identified Phillips's *Pl. tuberculatus* with *Pl. fritillus*, Müller,[8] but that species is evidently totally distinct from the present. It differs generically, and the large size of the attachment of its column and the smallness of the radials compared with the basals are points which easily distinguish even imperfect specimens.

*H. anaglypticus*, Goldfuss,[9] seems to approach the nearest to it of Eifel

[1] 1838, Phillips, 'Geol. Yorks.,' vol. ii, p. 204, pl. iii, fig. 17.

[2] 1821, Miller, 'Nat. Hist. Crinoids,' p. 81, pl. xxviii, fig. 1.

[3] 1881, Wachsmuth and Springer, 'Proc. Acad. Nat. Hist. Philad.,' pt. 2, p. 249.

[4] 1838, Phillips, 'Geol. Yorks.,' vol. ii, p. 204, pl. iii, fig. 19 (only).

[5] 1843, Austin, 'Monogr. Recent and Foss. Crinoids,' p. 41, pl. iv, figs. 3 *m*—*y*.

[6] 1852, F. Römer, 'Verhandl. n. Vereins. Rheinl.,' vol. ix, p. 281, pl. ii, fig. 1.

[7] 1867, Schultze, 'Densch. k. Acad. Wissen. Wien,' vol. xxvi, p. 181.

[8] 1855, Müller, in Wirtgen and Zeiler, 'Verhandl. n. Vereins Rheinl.,' vol. xii, p. 80, pl. x, figs. 4, 5.

[9] 1839, Goldf., 'Nov. Act. Akad. Leop.,' vol. xix, pt. 1, p. 348, pl. xxxii, fig. 4; and 1867, Schultze, 'Denksch. kais. Akad. Wissensch. Wien,' vol. xxvi, p. 184, pl. viii, fig. 1.

Crinoids, but it seems to have a more conical dorsal cup, a more expanded and shallower basal circlet, and a coarser and more nodulose ornament. Its anal plates seem narrower, and of a different shape. *H. elongatus*[1] seems a much smoother and more conical fossil, with larger basals.

3. Hexacrinus perarmatus, *Whidborne*. Pl. XXII, figs. 9, 10.

1889. Hexacrinus perarmatus, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup small, rather elongate, with slightly convex base, and nearly erect sides. Basal circlet small, nearly flat, hexagonal, formed of three plates. Radials five, rather unequal in width, elongate, very large, subquadrate, sometimes (but not always) expanding upwards, with a large notch or excavation occupying the whole of the upper margin. Anal large, oblong, rather broad (breadth $= \frac{2}{3}$ height), surmounted by a subcircular second anal plate, above which appears to be the anal opening. Primibrachs small, axillary, filling only a small part of the radial notch. First secundibrachs large, stout, lunate. Tegmen flat and rather contracted, with a large plate in front of the anus, which is surrounded by about seven other largish plates, most of the other plates of the dome being small, very nodulose, and indistinct. Suture-lines rather deep.

Ornament consisting of coarse, sharp, elevated pustules, radiating in lines from the tops of the radials, each plate being bounded by a row of rather larger pustules.

*Size of Calyx.*—Length 25 mm., width 25 mm., breadth 20 mm.

*Localities.*—A finely preserved calyx is in Mr. Vicary's Collection, and another in the Museum of Practical Geology from Wolborough. The cast of a calyx in my Collection from Lummaton seems to belong to the same species.

*Remarks.*—The plates of the tegmen are so confused in the only specimen in which they are shown that it seems impossible to decipher them. There seems among others to be one large interambulacral resting on the upper angle of each pair of radials. In front of the anal opening is a large plate, which seems surrounded by a ring of seven or eight plates, the rest of the plates of the dome being very small.

*Affinities.*—It seems rather doubtful whether this is more than a variety of *H. macrotatus*. It appears, however, to differ in the character of its ornament, which does not run into transverse ridges or become confluent, as in that species. The shape of the anal plates is also different; the first plate being larger and squarer, and the anal above it much smaller and shorter than in Austin's species.

[1] 1867, Schultze, 'Denksch. kais. Akad. Wissensch. Wien,' vol. xxvi, p. 186, pl. ix, fig. 4.

*H. anaglypticus*, Goldfuss,[1] is the nearest species given by Schultze. It seems separated by its more conical or less vasiform cup, its coarser and more irregularly confluent markings, and its less flattened basal circlet.

4. Hexacrinus ornatus, *Goldfuss*, sp. Plate XXII, figs. 11, 11 *a*.

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|---|---|---|---|
| 1839. | Platycrinus ornatus, *Goldfuss.* | | Nova Acta Acad. Leop., vol. xix, pt. 1, p. 347. |
| 1855. | Hexacrinus echinatus, *Sandberger.* | | Verst. Rhein. Nassau, p. 398, fig. 10. |
| 1867. | — | ornatus, *Schultze.* | Denksch. Kaiser. Acad. Wissensch. Wien, p. 11, pl. viii, figs. 4—4 *f*; and pl. x, figs. 9—9 *b* (upper figures only). |
| 1881. | — | — *Wachsmuth and Springer.* | Proc. Acad. Nat. Sci. Philad., p. 254. |
| 1889. | — | — *Whidborne.* | Geol. Mag., dec. 3, vol. vi, p. 79. |

*Description.*—Dorsal cup small, wide, with short erect sides. Attachment of column very large. Basal circlet wide, nearly flat or saucer-shaped, almost equal in size to width of the cup, regularly hexagonal in outline, consisting of three plates, and ornamented by four rows of exceedingly coarse tubercles, the lowest of which is turned outwards so as to form a raised ring of about eight sharp tubercles, and is separated from the rest by a very short neck. Radials five, flat, erect, short, covered by a few very coarse ridges and nodules, having a tendency to radiate, which sometimes form steep irregular walls. Upper part of calyx unseen. Suture-lines very wide, bevelled, and deep.

Stem consisting of short convex columnals, round which is a median band of about eight large, sharp, distant tubercles.

*Size of calyx.*—Width 17 mm., height 11 mm. or more.

*Locality.*—Wolborough. One calyx is in the Torquay Museum. A portion of stem is in Mr. Vicary's Collection, and another portion, which may belong to the same species, is in the Torquay Museum. I have found a few detached segments of the stem at Lummaton.

*Remarks.*—The great resemblance of these fossils, both calyx and stem, to the German figures of *H. ornatus* seems to leave no doubt of their identity.

The dorsal cup has deeper and more elaborate ornamentation than occurs in most of Schultze's figures, and its base is flatter and its attachment smaller. With Sandberger's type of *H. echinatus*, on the other hand, it agrees better, only differing in being rather larger. Schultze, after an examination of Sandberger's type, united it with Goldfuss's species, no doubt correctly.

[1] 1867, Schultze, 'Denksch. k. Acad. Wissen. Wien,' vol. xxvi, p. 184, pl. viii, figs. 1—1 *i*.

Our fossil is distinguishable by its width, its erect radials and spreading basals, its very large columnal attachment, and its curiously elaborate, coarse, and elevated sculpture. As it is defective above, there may be a question about its height, but after repeated examinations my opinion is that the missing part was in all probability very small indeed.

The fragment of stem in Mr. Vicary's Collection is just like the piece which is figured by Schultze. The other specimen differs in having alternating columnals in four series—the first and third being simple flat rings, the second being larger and convex but still very narrow, and the fourth being still larger and ornamented with five or six high sharp tubercles. It seems uncertain whether this specimen may be regarded as a different part of the stalk of the same animal, but I know nothing else to which it is likely to belong.

*Affinities.*—Of our English crinoids the only one which it approaches is *H. macrotatus*, but that seems distinguished by the more regularly ovoid shape of the calyx, by its less prominent ornament, and probably by its much greater height. There would be little doubt that it is a distinct species, even apart from the fact that it appears identifiable with a German fossil which is certainly distinct from Austin's English form.

5. Hexacrinus microglyphicus, *Whidborne*. Plate XXIII, figs. 1, 1 *a*, 2, 2 *a*.

1889. Hexacrinus microglyphicus, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup rather elongate, deeply cup-shaped, large. Attachment of column small. Basal circlet large, deep, consisting of three plates, with an hexagonal upper margin, and being slightly constricted below, so as to form a slight rim at the base of attachment. Radials elongate, being rather higher than wide, slightly convex at the lower margins, and slightly wider above than below. Anal elongate with angular lower margin, and with sides which arch gently inwards as they advance upwards, so that it is broader below than above. Surface covered by numerous small pustules, which occasionally arrange themselves in radiating lines.

*Size of calyx.*—The best specimen is 20 mm. high by 18 mm. wide. Another is 45 mm. high.

*Localities.*—From Wolborough there are three specimens in Mr. Vicary's Collection, and two in the Torquay Museum.

*Remarks.*—The material for this species is very poor, and it seems very doubtful whether it should be separated from the specimens identified with

*Pl. pentangularis*, Phillips (not Miller), and now described under the name *H. Vicarii*. There seems to be reason for separating them on account of their stouter form, and the smaller comparative length of their basals; but, until better specimens are discovered, it will be impossible to form any definite conclusion on the subject.

6. Hexacrinus Vicarii, *Whidborne*. Plate XXIII, figs. 4, 4 *a*, 5, 5 *a*.

1841. Platycrinus pentangularis?, *Phillips* (not *Miller* nor *Austin*). Pal. Foss., p. 135, pl. lviii, fig. 29**.

1889. Hexacrinus Vicarii, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup large, elongate, pear-shaped, decidedly oval in section, with arching sides. Attachment of column small, oval or circular, apparently with a triangular canal. Basal circlet very large and long, probably nearly half the height of the cup, deeply conical in shape with an hexagonal upper margin; consisting of three plates which are sometimes very unequal in size, one being much narrower than the rest. Radials (indistinctly seen) apparently five, elongate, wider above, and deeply and broadly notched at the upper margins. One anal plate, intercalated between the radials, elongate, being nearly twice as long as wide, rather narrower above than below, and convex at the shoulders. Suture-lines slight. Surface crowded with minute irregular pustules.

*Size of an imperfect calyx.*—Height 32 mm.; ratio of width to breadth about 5:6.

*Locality.*—There are three specimens from Wolborough in the Museum of Practical Geology.

*Remarks.*—These fossils seem to be sufficiently distinguished by their very elongate pear-like shape and the great relative length of their basals. They give the impression of not being symmetrical, the perpendicular contours being much more arching on some sides than others; but how far this was due to accident cannot be determined in the present very imperfect state of the specimens.

The species is clearly distinguishable from all the other fossils occurring at Wolborough, except perhaps from *H. microglyphicus*, which it much resembles. That species differs from it in the very decidedly smaller size of the basals and its stouter shape, but I am not certain that it may prove to be more than a variety of it.

Having compared a small fragmentary specimen in the Museum of Practical Geology with Phillips's figure, I think there is no doubt that this is the species referred by him to *Platycrinus pentangularis*, Miller;[1] and, if so, he was correct in

[1] 1821, Miller, 'Nat. Hist. Crinoidea,' p. 81, pl. xxix, fig. 4, 1–8.

counting his fossil as congeneric with *H. interscapularis*. I have not been able to find his figured specimen unless this one be the remains of it.

Miller's species does not seem founded on a true crinoid, but in part, if not altogether, on a Pentremite, one of his figures looking as if erroneously restored.

7. Hexacrinus quintangulus, *Whidborne*. Plate XXIII, figs. 6, 6 *a*, 7.

1843. Hexacrinus? pentangularis, *Austin*. Mon. Rec. and Foss. Crinoidea, p. 51, pl. vii, figs. 1 *a—e, i*.

1889. Platycrinus quintangulus, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup rather large, short, widely conical, becoming pentagonal in section at the top. Proximal columnal very narrow, circular, with a flat and smooth margin, having a narrow central, raised, finely crenulated band. Attachment of column large. Basal circlet large, deep, between one third and one half the height of the cup, margined above by an irregular hexagon with unequal concave sides, and slightly constricted below so as to form a narrow raised rim round the attachment. Basal plates three, apparently nearly equal, one plate (if not all) being hexagonal. Radials five, very large, rather longer than wide, with convex inferior margins, nearly straight sides, and wide shallow notches on the upper margins; each plate becoming centrally swollen and bluntly subangular in the upper part of its surface, so as to give a stellate appearance to the top of the cup. First primibrachs very small, narrow, not half filling the notches in the radials. Second primibrachs axillary, narrow, triangular, small, only partly filling the remainder of the notch. First secundibrachs rather large, sublunate, rayed on their upper articular surface. Arms nearly erect. Anal plate intercalated with the radials and of similar size, bluntly triangular in the lower margin, rather convex on the shoulders, with other plates above it, protruding in a short semicircular tube Surface unknown.

*Size of calyx.*—Height about 33 mm., width about 33 mm.

*Localities.*—From Wolborough two specimens are in the Museum of Practical Geology, and two in Mr. Vicary's Collection. From Lummaton a very indistinct calyx in my Collection seems to belong to this species.

*Remarks.*—These specimens are all too defective to give a very clear idea of the species. One of the two in the Museum of Practical Geology was figured by Austin as "*Hexacrinus? pentangularis* (Phillips)," but it certainly does not belong to Miller's or Phillips's fossils, which in no way agree with the present species. Therefore, though Austin has changed the genus, it hardly seems wise to retain a specific name that has descended to it from another species, and therefore a fresh name has been suggested.

Austin's specimen hardly seems to show all the particulars in regard to the arms which he describes, and it is only smooth because its surface is destroyed. Its anal parts have unfortunately been scraped away, but one of Mr. Vicary's specimens shows them better. The anal plate is seen to be headed by a short projecting tube which is channelled within, but the division of its plates is obliterated, and, the specimen being fractured at the top, it is impossible to tell what length it reached. The first columnal is seen in this specimen.

*Affinities.*—The three forms, *H. microglyphicus*, *Vicarii*, and *quintangulus*, are evidently closely related, and from the poverty of our meterial it is exceedingly hard to decide how far the observable differences are specific; at the same time each form does seem to have a facies of its own, which makes it likely that the distinctions would be more definite if the specimens were better.

The present form bears some resemblance to *H. pateræformis*, Schultze,[1] but its calyx is deeper and much more definitely hexagonal.

### 8. Hexacrinus ? aberrans, *Whidborne*. Plate XXIII, fig. 3, and Plate XXV, figs. 2—2 *c*.

1889. Platycrinus aberrans, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup small, elongate, conical, with slightly convex sides. Attachment of column large, triangularly petalliform, with smooth lower surface except a row of small short crenulations close to the margin. Basal circlet cup-shaped, deep, about one-third the height of the cup, with an irregularly polygonal upper margin, and a constriction forming a small rounded narrow rim at the inferior margin; consisting of three subequal plates, rather broader than high. Radials five, very large, elongate, subhexagonal, with straight rather expanding sides, and with a large deep, semi-elliptic notch extending over the whole upper margin. First primibrachs very small, linear, only partially filling the notch. Second primibrach wide, very short, axillary, triangular at the centre. Anal plates two in the first row, resting on two of the basals, one being narrow, very elongate, hexagonal, and very much smaller than the radials; the other being of the same size as the radials, but irregular in shape, and produced above into a slight neck or tube, which perhaps is composed of other plates. Structure of plates very thick. Suture-lines rather deep, with a small bevelled border. Surface bearing numerous small obscure pustules.

*Size.*—Height 45 mm., width 35 mm.

[1] 1867, Schulzte, 'Denksch. k. Acad. Wissen. Wien,' vol. xxvi, p. 199, pl. x, figs. 4—4 *c*.

*Locality.*—Lummaton. There is a small but fine calyx and a detached radial in the Lee Collection in the British Museum, and a much larger but very indistinct cast in my Collection.

*Remarks.*—Though the material at hand for describing this form is so scanty, it presents some points which suggest specific or possibly generic distinction. Thus the trilobate surface of the base indicates a rather curiously shaped column, while the fact of there being apparently seven plates resting on the basals seems remarkable. Of these, five are ordinary radials; the sixth, though of similar size, is of decidedly irregular shape; while the seventh is much smaller, elongate, hexagonal, and seems to occupy the same relative position as anal ×.

Should the arrangement of the anal plates prove (as is certainly possible) an accidental malformation, it would present such an approach to *H. elongatus*, Goldfuss,[1] sp., or still more to *H. piriformis*, Schultze,[2] as to make it possible that it might be a variety of one of them, though the former is distinguished by its coarse and more confluent ornament, and the latter by its much longer basals. To Eifel specimens of the former in Mr. Lee's Collection it is certainly very like, and in Mr. Bather's view probably identical.

## II. *Family.*—Melocrinidæ, *F. Römer*, 1855.

### 1. *Genus.*—Melocrinus, *Goldfuss*, 1826—1834.

Basals 4, radials 5, primibrachs 2 × 5, secundibrachs 2 or 3 × 10.

1. Melocrinus stellaris, *F. Römer*, sp.? Plate XXIII, fig. 12.

| | | | | |
|---|---|---|---|---|
| 1852. | Ctenocrinus stellaris, | *F. Römer.* | | Verhandl. n. Vereins Rheinl., vol. ix, p. 282, pl. ii, figs. 2 *a—c*. |
| 1855. | — | — | — | In *Bronn's* Lethæa Geogn., edit. 3, vol. i, p. 254, pl. iv[1], figs. 19 *a*, *b*. |
| 1867. | Melocrinus stellaris, | *Schultze.* | | Denksch. k. Acad. Wissen. Wien, p. 177, pl. vi, figs. 3—3 *b*. |
| 1881. | — | — | *Wachsmuth and Springer.* | Proc. Acad. Nat. Sci. Philad., p. 296. |

*Description.*—Dorsal cup of moderate size, rather lofty. Attachment of column apparently large, elliptic or circular? Basals (very indistinctly visible) four? Radials and primibrachs 3 × 5, decreasing in size, hexagonal. Secundibrachs 2 × 10.

[1] 1839, Goldfuss, 'Nova Acta Acad. Leop.,' vol. xix, p. 345, pl. xxii, fig. 1.

[2] 1867, Schultze, 'Denksch. k. Acad. Wissen. Wien,' vol. xxvi, p. 188, pl. x, figs. 1—1 *c*.

Interradials, first row, five, lying between the radials and first primibrachs; second row, ten, lying between the first and second primibrachs; third row, ten, level with first row of secundibrachs; fourth row, ten, level with second row of secundibrachs. Plates all approximately hexagonal, regularly decreasing in size upwards, deeply convex or bluntly pyramidal in their centres, which are connected by steep prominent radiations.

*Size* of imperfect calyx, 22 mm. by 25 mm.

*Locality.*—A single specimen was found by Mr. J. G. Grenfell on the shore at Torquay, in red crystalline limestone.

*Remarks.*—This interesting specimen belongs to a part of the Devonian series different from the Lummaton beds; but having, by the kindness of Mr. Grenfell, the opportunity of figuring it, I have introduced it here. Its true shape is lost as it is obliquely crushed, and only part of its surface is seen, so that its description is in some degree tentative. After a very careful examination of it, however, I think that the above interpretation is in all probability correct, judging from the two radial and two interradial areas that can be observed. If this be so the resemblance to F. Römer's species, in shape, in the arrangement of plates, and in the style of ornament, is so great that it most probably belongs to that species; the only perplexing point being that the upper rows of interradials seem to be two instead of three in each area. The surface is a good deal injured, but the ornamentation appears to be of the nature which Schultze describes as characteristic of this species.

2. MELOCRINUS HIEROGLYPHICUS, *Goldfuss?* Plate XXIV, figs. 1, 1 *a*, 1 *b*.

| | | | |
|---|---|---|---|
| 1826—1834. | MELOCRINUS HIEROGLYPHICUS, *Goldfuss.* | | Petref. Germ., vol. i, p. 197, pl. lx, figs. 1 A—E. |
| 1833—1838. | — | — | *Bronn.* Leth. Geogn., vol. i, p. 63. |
| 1838. | — | — | *Goldfuss.* Nova Acta Acad. Leop., vol. xix, p. 339. |
| 1856. | — | — | *F. Römer.* In *Bronn's* Leth. Geogn., edit. 3, vol. i, p. 251, pl. iv, figs. 10 *a—c.* |
| 1870. | — | — | *Kayser.* Zeitsch. Deutsch. Geol. Gesell., vol. xxii, p. 847. |
| 1881. | — | — | *Wachsmuth and Springer.* Proc. Acad. Nat. Sci. Philad. p. 295. |
| 1886. | — | — | *Koenen.* Neues Jahrb. f. Min., pt. 1, p. 103, pl. i, figs. 1 *a—g.* |

*Description.*—Dorsal cup rather small, pyriform. Attachment of column rather large. Basal plates narrow, unequal. Radials five, hexagonal. Primibrachs in two rows. Secundibrachs? First interradial large, hexagonal, situated between the radials and first primibrachs, succeeded by two rather smaller hexagonal interradials. Tegmen flat, rather constricted, covered by numerous small plates. Anal aperture lateral. Plates bearing low irregular rugosities.

*Size.*—About 19 mm. high, 23 mm. wide, 20 mm. broad.

*Locality.*—There is a specimen in the Torquay Museum. As in most of the other fossils in this Museum, the locality has not been preserved, but it has the character of the Lummaton Beds.

*Remarks.*—This calyx is nearly perfect although obliquely crushed, but unfortunately the surface is so much cracked and injured that its ornament is almost destroyed, and comparatively few of the plates can be exactly traced. After comparing it, however, with Goldfuss's figures of *M. hieroglyphicus*, it seems to me that its likeness to them is so great that it may belong to the same species though it is less like those of later authors. Specimens of *M. mespiliformis*, Fraipont,[1] kindly shown me by Mr. Bather, closely resemble its shape (as crushed), but differ in being smooth.

## III. *Family.*—Rhodocrinidæ, *F. Römer*, 1855.

### 1. *Genus.*—Thylacocrinus, *Œhlert*, 1879.

1. Thylacocrinus? sp. Plate XXIII, fig. 11.

*Size of fragmentary specimen.*—Height 20 mm., width 18 mm.

*Locality.*—A single specimen is in my Collection from Lummaton.

*Remarks.*—This specimen is a well-preserved fragment containing about 20 small massive plates, which are more or less perfect hexagons, and have deeply bevelled margins and irregularly corrugated surfaces. Their interpretation is very difficult, but I find that they may be matched plate by plate with part of the calyx of *Thylacocrinus Vannioti*, Œhlert,[2] though rather smaller in size. If this be so, a row of basals is succeeded by three rows of radials and brachials in each area, between which is seen an interradial followed by a second row of two. In spite of the imperfection and doubtfulness of the specimen, it seems worth recording, as it evidently belongs to a crinoid undescribed from South Devon.

[1] 1883, Fraipont, 'Ann. Soc. Géol. Belg.,' vol. x, p. 63, pl. 5, figs. 8—10.

[2] 1879, Œhlert, 'Bull. Soc. Géol. Fr.,' sér. 3, vol. vii, p. 7, pl. i, fig. 3.

**2.** *Genus.*—Rhipidocrinus, *Zittel*, 1876.

This genus "differs very materially in the arm-structure from *Rhodocrinus* as established by Miller" (Wachsmuth and Springer).

**1.** Rhipidocrinus crenatus, *Goldfuss*, sp.? Plate XXIII, figs. 8, 8 *a*.

| | | |
|---|---|---|
| 1827. | Rhodocrinites crenatus, *Goldfuss.* | Petref. Germ., vol. i, p. 211, pl. lxiv, fig. 3. |
| 1835. | — — *Agassiz.* | Mém. Soc. Neufchatel, vol. i, p. 196. |
| 1851. | Rhodocrinus crenatus, *F. Römer.* | Verh. Nat. Vereins Rheinl., vol. viii, p. 358, pl. i, fig. 1. |
| 1853. | — tessellatus, *Steininger.* | Geogn. Besch. Eifel., p. 36. |
| 1855. | — — *F. Römer.* | In *Bronn's* Lethæa Geogn., edit. 3, vol. i, p. 241, pl. iv. figs. 17 *a*, *b*. |
| 1867. | — crenatus, *Schultze.* | Denksch. Kais. Akad. Wissensch., vol. xxvi, p. 165, pl. vii, fig. 1. |
| 1876. | — — *F. Römer.* | Lethæa Pal., pl. xxvii, fig. 14. |
| 1880. | Rhipidocrinus crenatus, *Zittel.* | Handbuch Palæont., p. 377, fig. 263. |
| 1881. | Ripidocrinus crenatus, *Wachsmuth and Springer.* | Proc. Acad. N. S. Philad. p. 379. |
| 1889. | Rhodocrinus crenatus?, *Whidborne.* | Geol. Mag., dec. 3, vol. vi, p. 79. |

*Description.*—Calyx of moderate size, oblately spheroidal, with concave base. Attachment of column large, circular, with radiating striæ. Basals? Radials and primibrachs 3 × 5? transverse. Secundibrachs 2 × 10? Interambulacrals hexagonal, first row 5, medial between the radials and the first primibrachs; second row 10, smaller. Surface of plates convex, structure very massive. Tegmen constricted, flattish.

*Size of calyx.*—Height about 20 mm., width 45 mm.

*Locality.*—One worn specimen from Lummaton is in my Collection, and another, probably from the same locality, in the Torquay Museum.

*Remarks.*—These specimens are so badly preserved as to be almost undecipherable; in one the plates are entirely obliterated, and in the other they can only be traced approximately. The general shape of the calyx, however, is evident, and is totally unlike any other South Devon crinoid. Mr. Bather agrees with me that they probably belong to *Rhodocrinus crenatus*, Goldfuss, though the basals are very much smaller than usual in this species, so small indeed as to be unobservable in these specimens.

### 3. *Genus.*—Rhodocrinus, *Miller*, 1821.

1. Rhodocrinus (Acanthocrinus), sp. Plate XXIV, figs. 6, 6 *a*.

*Remarks.*—A small decorticated specimen from Wolborough in the Museum of Practical Geology deserves notice. It is a basal or radial plate in the form of a regular hexagon, which is produced centrally into a very elongate, conical, gently arching spine. The margins of the plate slope inwards and are slightly grooved laterally. It measures 4 mm. across and 11 mm. in length.

It seems exactly to correspond with the spiniferous basal and radial plates of *Acanthocrinus longispinus*, F. A. Römer,[1] as figured and described by Müller;[2] the only difference being that in the latter the spines appear straight instead of arching.

An almost identical (but straight) specimen was described as a calyx under the name of *Eugeniacrinus? hexagonus* by Münster[3] from the Carboniferous of Tournay, and doubtless belongs to a kindred species.

Wachsmuth and Springer[4] consider that *Acanthocrinus* cannot be distinguished from *Rhodocrinus* even as a sub-genus.

## 2. Order.—INADUNATA, *Wachsmuth and Springer*, 1886.

### 1. Sub-order.—Larviformes, *Wachsmuth and Springer*, 1886.[5]

#### I. *Family.*—Haplocrinidæ, *F. Römer*, 1855.

### 1. *Genus.*—Haplocrinus, *Steininger*, 1834.

Calyx small, subglobose. Basals five, small, pentagonal. Radials five; left posterior and anterior consisting of single heptagonal plates, and the other three horizontally bisected; all with the upper articular faces horizontal. Tegmen consisting of five triangular orals, laterally grooved to receive the arms. Anal-opening under the upper angle of the posterior oral.

Devonian and Carboniferous.

[1] 1850, F. A. Römer, 'Neues Jahrb. f. Min.,' p. 679, pl. vi, fig. 1, 2

[2] 1855, Müller, in 'Zeiler und Wirtgen, Verh. N. Vereins,' vol. xii, p. 8, pl. ii, figs. 1—3, and pl. iii, figs. 1, 2.

[3] 1839, Münster, 'Beitr.,' pt. i. p. 34, pl. i, fig. 6.

[4] 1881, Wachsmuth and Springer, 'Proc. Acad. N. S. Philad.,' p. 354.

[5] In place of *Larviformes* and *Fistulata*, Mr. Bather (in 1893, 'Crinoidea of Gotland,' pt. 1, p. 20) tentatively divides the *Inadunata* into *Monocyclica* and *Dicyclica*, regarding the existence of an infra-basal circlet as being in this order of sufficient importance for a primary division.

1. Haplocrinus decipiens, *Whidborne*. Plate XXIII, figs. 9, 9 *a*.

1889. Haplocrinus decipiens, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description*.—Calyx minute, subglobose, rather low, pentagonal in transverse section at the springing of the arms. (Basal plates unseen.) Radials horizontally straight above, produced in the centre to form on the upper margin a squarish greatly-protruding arm-facet, which is deeply excavated upon its upper surface; while the sides of adjoining radials form a nearly flat surface. Oral plates five, large, elevated, triangular, with flat lower margins and concave lateral margins, forming together a low pentagonal pyramid with wide oval grooves at the angles, and with each side resting on two of the radials. Posterior oral wider than the rest, and apparently produced over the apex in a central tongue. Postero-lateral orals narrow.

*Size of calyx*.—Height about 5 mm., width 5 mm.

*Locality*.—A single specimen is in my Collection from Lummaton.

*Remarks*.—When first discovered only the upper part of this little fossil was visible, and it was then supposed by my friend Mr. J. E. Lee and myself to be a Pentremite;[1] on submitting it, however, to Mr. P. H. Carpenter, he succeeded in clearing away the matrix and proving it to belong to the genus *Haplocrinus*. The specimen, however, still remains too much confused with the matrix to allow its details to be accurately described, the basals and lower radials being hidden, and lower parts of the upper radials being obscured, though their lateral sutures are seen. The upper part of the specimen is more distinct. The facets for the arms are greatly developed, forming definite squarish prolongations from the centres of the radials; the articular faces of the radials are separated from the oral plates by a deep impressed line; the oral plates are laterally concave, and so bevelled that their external summits end at some distance below the apex. Here again the fossil becomes indistinct, so that it can only be said that the posterior plate appears (had it been perfect) to have surpassed the others.

*Affinities*.—This fossil is so much like *H. stellaris*, F. Römer,[2] that it may be a question whether it is specifically distinct. Judging, however, from Römer's figure, the German species has a shallower and more expanding calyx, its radials are much less erect, its tegmen is considerably higher than the dorsal cup, and the grooves between the oral plates are narrower. It therefore seems that the English fossil is most probably distinct.

[1] 1881, Whidborne, 'Geol. Mag.,' dec. 2, vol. viii, p. 288.

[2] 1844, F. Römer, 'Rhein. Uebergangsgeb.,' p. 63, pl. iii, figs. 5 *a*—*d*.

From the type species of the genus, *H. mespiliformis*, Goldfuss,[1] sp., it is still further removed. Its tegmen is lower, its dorsal contour is more angular, the centres of its radials are much more produced, so as to give a stellate rather than a simply pentangular section, while the sides of the ventral grooves are curved instead of straight, forming with the insertion of the arms a figure of eight. *H. granatus*, de Koninck,[2] from the Carboniferous of Yorkshire, is a more elongate species, with a higher tegmen and much less stellate horizontal contour.

## II. *Family.*—Symbathocrinidæ, *Wachsmuth and Springer*, 1886.

### 1. *Genus.*—Storthingocrinus, *Schultze*, 1867.

1. Storthingocrinus fritillus, *Müller*, sp. Plate XXIII, figs. 10, 10 *a*.

? 1853. Platycrinus minutus, *Schnur*. In *Steininger's* Geogn. Besch. Eifel., p. 37.
1855. — fritillus, *Müller*. In *Wirtgen and Zeiler*. Verhandl. Nat. Vereins Rheinl., p. 80, pl. x, figs. 4, 5.
1867. — (Storthingocrinus) fritillus, *Schultze*. Denksch. Akad. Wissensch. Wien, vol. xxvi, p. 181, pl. x, figs. 8—8 *f*.
1886. Stortingocrinus fritillus, *Wachs. and Springer*. Proc. Acad. N. S. Philad., p. 96.
1889. Platycrinus fritillus, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 79.

*Description.*—Dorsal cup small, rather elongate, deeply vasiform, oval in section. Attachment of column extremely large. Basals three, rather high, and apparently hexagonal in shape (one perhaps being pentagonal), forming a very deep cup. Radials five, erect, quadrate, rather elongate; no intercalated anal. Suture-lines deep and broadly angular.

*Size of calyx.*—Height 9 mm., width 9 mm., breadth 7 mm.

*Locality.*—Wolborough. A single specimen is in Mr. Vicary's Collection.

*Remarks.*—This little fossil is in an extremely bad state of preservation, and difficult to decipher with any degree of certainty.

It seems, however, certain that it has no intercalated anal plate, and therefore does not belong to the genus *Hexacrinus*.

On the other hand, it appears accurately to correspond with Wirtgen and Zeiler's and Schultze's figures of *Storthingocrinus fritillus*, agreeing in all the

[1] 1826–34, Goldfuss, 'Petref. Germ.,' vol. i, p. 213, pl. lxiv, fig. 6; 1882, Barrois, 'Mém. Soc. Géol. Nord,' vol. ii, p. 222, pl. viii, fig. 11, 11 *a*; and 1885, Wachsmuth and Springer, 'Proc. Acad. Nat. Sci. Philad.,' p. 361, pl. v, figs. 1, 2; and 1886, p. 86; and 1887, ibid., p. 362, pl. xviii, figs. 6, 6 *a*.

[2] 1869, de Koninck, 'Bull. Acad. Royale Belg.,' ser. 2, vol. xxviii, p. 63, pl. v, figs. 6—10.

characters that are observable. The facet of attachment is very large, being about half the width of the calyx; the basals are large and erect, and reach rather high up; the radials are rather short; the suture-lines are clear and somewhat excavate, and the general facies of the fossil so closely corresponds with the German species that there is a presumptive reason for identifying it with it.

A small calyx, wanting the basal plates, in the Museum of Practical Geology, is most probably the original both of Phillips's 'Pal. Foss.' figure, pl. lx, fig. 39 (*Pl. tuberculatus*), and of Austin's 'Crinoids,' pl. vi, fig. 3 *b* (*H. macrotatus*). Schultze has recognised the specific agreement of these figures of the two English authors, and rightly, inasmuch as they are in all probability both drawn from the same specimen. When, however, Müller and he identify them with *St. fritillus* there seems reason for dissent. The original specimen (from which both figures are drawn) seems to agree with the other fossil figured as *H. macrotatus* by Austin, as well as with other specimens which show that species to be larger than, and quite distinct from, *St. fritillus*, and clearly to belong to the genus *Hexacrinus*.

Wachsmuth and Springer definitely separated this species from *Platycrinus* on account of the arrangement of the upper part of the calyx which is unseen in our only English specimen.

### III. *Family.*—Cupressocrinidæ, *F. Römer*, 1855.

### 1. *Genus.*—Cupressocrinus, *Goldfuss*, 1826—1834.

Column with central and lateral canals. Dorsal cup broadly vasiform. Infra-basal circlet undivided, pentagonal. Basals five, equal, pentagonal. Radials five, wide, pentagonal. Muscle-plates large anchylosed, horizontal, pierced by ambulacral and anal grooves. Arms five, simple, composed of massive transverse quadrate plates.

Mr. Bather is disposed to consider that the supposed infra-basal circlet is really the enlarged proximal columnal of the stem.

1. Cupressocrinus crassus, *Goldfuss*. Plate XXIV, figs. 4, 4 *a*.

| | | | |
|---|---|---|---|
| 1826. | Cupressocrinus crassus, *Goldfuss*. | | Petref. Germ., vol. i, p. 212, pl. lxiv, fig. 4. |
| 1833. | — | — | *Bronn*. Leth. Geogn., vol. i, p. 64. |
| 1835. | — | — | *Agassiz*. Mém. Soc. Neuchatel, vol. i, p. 198. |
| 1839. | — | — | *Goldfuss*. Nov. Acta Akad. Leop., vol. xix, pt. 1, p. 331, pl. xxx, fig. 1. |

| | | | | |
|---|---|---|---|---|
| 1839. | Cupressocrinus | tetragonus, | *Goldfuss.* | Nov. Acta Akad. Leop., vol. xix, pt, 1, p. 332, pl. xxx, fig. 3. |
| 1849. | — | crassus, | *d'Orbigny.* | Prodrom., vol. i, p. 102. |
| 1853. | Cypressocrinus | — | *Steininger.* | Geogn. Besch. Eifel, p. 36. |
| | — | — | — | Versteiner. Eifel, p. 20. |
| 1855. | Cupressocrinus | — | *F. Römer.* | In *Bronn's* Leth. Geogn., edit. 3, p. 232, pl. iv, figs. 9 *a—c*. |
| 1860. | — | — | *Bronn.* | Classen Thierreichs, vol. ii, pl. xxviii, fig. 1. |
| 1862. | — | — | *Dujardin and Hupé.* | Hist. Nat. Zool. Echin., p. 112, pl. xxviii, fig. 1. |
| 1867. | — | — | *Schultze.* | Denksch. Kaiser. Akad. Wissensch. Wien, p. 134, pl. i, figs. 1—1 *m*. |
| 1876. | — | — | *F. Römer.* | Leth. Pal., pl. xxvii, fig. 5. |
| 1880. | — | — | *Zittel.* | Handbuch Palæont., vol. i, pt. 1, p. 349, figs. 236 *a—g*. |
| 1886. | — | — | *Wachsmuth and Springer.* | Proc. Acad. N. S. Philad., p. 104. |

*Description.*—Dorsal cup of moderate size, deep, sub-cylindrical. Infra-basals (or proximal columnal) very small forming a pentagon very slightly wider than the column, which is seen from its facet of attachment to have been quadrate and pierced by four lateral canals. Basals five, equal, very tumid, set nearly vertically and of a height equal to their width. Radials five, equal, pentagonal, definitely tumid, of a height equal to two-thirds of their width; their straight upper margins forming an horizontal pentagon. Surface apparently without ornament.

*Size of dorsal cup.*—Height 15 mm.; width 23 mm.

*Locality.*—A defective dorsal cup and the remains of an infra-basal ring from Wolborough are in the Museum of Practical Geology.

*Remarks.*—While identifying these specimens with *C. crassus*, I should not have ventured on separating them from the other imperfect specimens mentioned below, except after the decidedly expressed opinion of so high an authority on Crinoids as Mr. Bather. Of the figured specimen he remarks: "the verticality of the basals, the slight swelling of the radials, and the apparently smooth surface separate it from *C. Schlotheimii*, Steininger, and *C. elongatus*, Goldfuss."

*Affinities.*—*C. inflatus*, Schultze,[1] has a larger infra-basal ring, and only three subsidiary canals in the column, but in general shape it is very similar.

*C. hieroglyphicus*, Schultze,[2] has an elaborate ornamentation and a larger infra-basal ring.

*C. scaber*, Schultze,[3] is very similar, but seems more cylindrical, its infra-basal

[1] 1867, Schultze, 'Denksch. k. Akad. Wissen. Wien,' vol. xxvi, p. 136, pl. i, figs. 2—2 *i*.

[2] Ibid., vol. xxvi, p. 137, pl. i, figs. 3—3 *d*.

[3] Ibid., vol. xxvi, p. 137, pl. i, figs. 4—4 *b*.

ring seems quadrilateral, and its surface is rugose, which would at once distinguish it if well preserved.

*C. gracilis*, Goldfuss,[1] has a larger infra-basal ring, and is more conical and generally much more elongate.

2. Cupressocrinus Schlotheimii, *Steininger*, sp. Plate XXIV, figs. 3, 3 *a*, 3 *b*, 5, 5 *a*.

| | | | |
|---|---|---|---|
| 1834. | Halocrinites Schlotheimii, *Steininger*. | | Mém. Soc. Géol. Fr., vol. i, p. 349, pl. xxi. fig. 1, 1 *a*. |
| 1838. | — | pyramidalis, *Steininger*. | Bull. Soc. Géol Fr., ser. 1, vol. ix, p. 295, pl. vi, figs. 1, 2. |
| 1839. | Cupressocrinus abbreviatus, *Goldfuss*. | | Nova Act. Acad. Leop., vol. i, p. 333, pl. xxx, fig. 4. |
| 1850. | — | Urogalli, *F. A. Römer*. | Beitr. Harzgeb., part 1, p. 9, pl. ii, fig. 7. |
| 1853. | — | Schlotheimii, *Steininger*. | Geol. Besch. Eifel, p. 36. |
| 1855. | — | nodosus, *Sandberger*. | Verst. Rhein. Nassau, p. 401, pl. xxxv, figs. 5—5 *c*. |
| 1855. | — | abbreviatus, *F. Römer*. | In *Bronn's* Leth. Geogn., edit. 3, vol. i, p. 232. |
| 1867. | — | abbreviatus, *Schultze*. | Denksch. Kais. Acad. Wissensch., vol. 26, p. 131, pl. 2, figs. 1—13, and pl. iii, fig. 3. |
| 1876. | — | — *F. Römer*. | Leth. Pal., pl. xxvii, fig. 11. |
| 1886. | — | — *Wachsmuth and Springer*. | Proc. Acad. N. S. Philad., p. 105. |

*Description.*—Dorsal cup of moderate size, shallow, vasiform. Infra-basals very small, united to form a pentagonal ring, very slightly wider than the column, which is seen from its facet of attachment to have been quadrate, and pierced by four lateral canals.

Basals five, equal, pentagonal, moderately convex or tumid, set obliquely; their height equal to their greatest width.

Radials five, equal, pentagonal, slightly convex, their height being half their greatest width, and their upper margins being straight horizontal lines, so that the section of the cup at this point is a regular pentagon. (Consolidating apparatus unseen in the English specimens.) The only ornamentation visible being a linear groove parallel and close to the margins of the basals and radials.

Arms with several of the plates apparently anchylosed together, so as to appear a single massive plate when viewed from within. Arm-plates consisting of two parallel steep triangular ridges forming a wide angular ambulacral groove,

[1] 1826–34, Goldfuss, 'Petref. Germ.,' vol. i, p. 213, pl. lxiv, fig. 5.

extending into the deep axial canal, which is not separated from the groove by a calcareous wall. Inner sides of ambulacral groove marked by coarse transverse rounded striæ, alternating with marginal sulci. Base of the first brachial widened horizontally, and obliquely bevelled or truncated downwards from its ventral surface, forming two smooth margined triangles, marked only by two small short ridges near the base of the central groove; and having a strongly-marked fulcral ridge with a linear depression on either side of the axial canal and ventrad of the ridge.

*Size of calyx.*—Height 16 mm., width 30 mm. A portion of the arm 18 mm. high, and without apparent articulation, measures 12 mm. wide.

*Localities.*—From Wolborough there is a fine calyx in Mr. Champernowne's Collection, another in the Torquay Museum, and another in the British Museum. In my Collection is a specimen of the lower part of one of the peculiar arms from Lummaton.

*Remarks.*—As the consolidating apparatus is unseen in our specimens of *Cupressocrinus*, it is rather difficult to decide their species. It will be seen that while one of our figured calyces exactly corresponds with figures of *C. crassus*, the other is equally like *C. nodosus*, Sandberger, which is generally regarded as a synonym of *C. abbreviatus*, Goldfuss. Schultze remarks that rolled specimens of the latter are very like the former. In the opinion of my friend Mr. Bather, both species occur in England, and of the present form he notes that "the greater horizontality of the basals, the greater proportional width of the radials, and the traces of concentric ridging on the cup plates separate it from *C. crassus* and *C. elongatus*, Goldfuss.[1]"

The curious specimen of the arm may be compared with a similar figure of that of *C. abbreviatus*, var. *minor*, given by Schultze. It would appear to consist of several segments so cemented together as to obliterate their divisions, rather than of a single elongated segment.

### 2. Sub-order.—Fistulata, *Wachsmuth and Springer*, 1886.

### I. *Family.*—Cyathocrinidæ, *F. Römer*, 1855.

### 1. *Genus.*—Sphærocrinus, *F. Römer*, 1851.

The validity of this genus is doubtful. It seems distinguishable from *Cyathocrinus* by the number of its anal plates, and from *Poteriocrinus* by the horse-shoe-like facets for the brachials. Though, according to Mr. Bather, it may prove synonymous with *Parisocrinus*, it seems simplest for the present to retain it as distinct, pending the discovery of its arms.

[1] 1838, Goldfuss, 'Nova Acta Akad. Leop.,' vol. xix, pt. 1, p, 331, pl. xxx, fig. 2.

1. Sphærocrinus geometricus, *Goldfuss*, sp. Plate XXIV, figs. 7—10.

1826–34. Cyathocrinus geometricus, *Goldfuss*. Petref. Germ., vol. i, p. 189, pl. lviii, fig. 5.
1841. — — *Phillips*. Pal. Foss., p. 135, pl. lx, fig. 41*.
1843. — — *Austin*. Recent and Fossil Crinoids, p. 61, pl. vii, figs. 5 *a—e*.
1851. Sphærocrinus geometricus, *F. Römer*. Verh. Nat. Vereins Rheinl., vol. viii, p. 366, pl. viii, fig. 1.
1853. — stellatus (*Schnur*), *Steininger*. Geogn. Besch. Eifel, p. 38.
1855. — geometricus, *Sandberger*. Verst. Rhein. Nassau, p. 390, pl. xxxv, fig. 14.
1855. — sp., *F. A. Römer*. Beitr. Harz., pt. 3, p. 22, pl. iv, fig. 15.
1856. Poteriocrinus geometricus, *Müller*. Abhandl. Berlin. Akad. Wissensch., p. 250, pl. ii, figs. 4—7; and pl. iv, figs. 1—3.
1856. — hemisphæricus, *Müller*. Monats. Berlin. Akad. Wissensch., p. 354.
1867. — geometricus, *Schultze*. Denksch. Akad. Wissensch. Wien, vol. xxvi, p. 163, pl. v, figs. 6 *a—l*.
1879. Cyathocrinus geometricus, *Wachsmuth and Springer*. Proc. Acad. N. S. Philad., p. 308.
1886. Sphærocrinus ? geometricus, *Wachsmuth and Springer*. Ibid., p. 150.
1892. Parisocrinus ? geometricus, *Bather*. Ann. Mag. Nat. Hist., ser. 6 vol. ix, p. 208.

*Description.*—Calyx sometimes very large, usually rather small, short, oblately spheroidal. Attachment of column rather large. Infra-basal circlet large, pentagonal, consisting of five lozenge-shaped (or pentagonal by the truncation of their proximal margins) plates, which are rather longer than wide. Basals five, hexagonal, wider than long, large. Radials five, rather small, unequal, incurved. Anal area containing a radianal, an anal ×, and another small plate on the right of anal ×, and resting on the radianal. Arms five, erect. Ventral side contracted. Ornament consisting of parallel, elevated, radiating ridges, starting from the centres of the infra-basal circlet, and of the basal plates, and from the insertion of the arms, so as to form a curious geometric pattern over the whole calyx.

*Size.*—An imperfect calyx measures from the arms to base 30 mm, width 45 mm. Another perfect specimen measures 20 mm. in height, and 30 mm. in width.

*Localities.*—From Wolborough there are eight specimens in the Museum of Practical Geology, two in Mr. Vicary's Collection, two in the Torquay Museum, and two in my Collection. From Lummaton there is a cast in my Collection.

*Remarks.*—There is no doubt of the specific identity of these fossils, but their generic position is a matter of much difference of opinion. Originally referred to *Cyathocrinus*, the species was made the type of a new genus by F. Römer, united to *Poteriocrinus* by Müller and by Schultze, first reunited to *Cyathocrinus*, and then again separated under Römer's name by Wachsmuth and Springer, while Bather,[1] who discusses the question fully, remarks, in conclusion, "As long as the arms of this species remain unknown one cannot definitely say to which genus it belongs; it would probably be safer to place it in *Parisocrinus*, but we may be quite certain that it has nothing to do with *Cyathocrinus*." In 1888 he informed me that it clearly did not belong to *Poteriocrinus*. It may be observed that if it were rightfully joined to *Parisocrinus*,[2] that name would rightfully become a synonym of *Sphærocrinus*, which was founded long before.

None of our English specimens enable us to form a very clear conception of its anal arrangement. A rather large rhomboidal or subpentagonal radianal is clearly seen, above which are two other anals, one of which is very small. None of our specimens show any plates of the dome. The calyx is perhaps rather more globose than in the German specimens, the circle of the insertion of the arms being much smaller compared with the greatest circumference of the calyx. The English specimens are sometimes much larger than the German, though the detached plate figured by F. A. Römer, which evidently belongs to this species, very nearly approaches them.

In the Lee Collection in the British Museum are sixteen good calyces from the Eifel, which agree with Schultze's figures in being much smaller in general size than ours, and in having rather fewer enclosed triangles in the ornament (at most three). One of them proves clearly that the cast from Lummaton belongs to this species.

*Anal tube of a Crinoid?* Plate XXIV, figs. 2, 2 *a*.

*Remarks.*—In the Torquay Museum is a specimen which apparently came from Lummaton, and appears probably to be the anal tube of some large species of Crinoid. It consists of an elongate subcylindrical tube, slightly recurved and composed of rows of imbricated plates (of which seven rows are visible) raised along their centres, so that seven longitudinal ridges are seen to run down its surface. The arrangement of these plates does not seem similar to those of the large anal tubes seen in species of *Poteriocrinus* from North Devon. Whether it belongs to the same species as the much shorter and more conical specimen from Newton, figured by

[1] 1892, Bather, 'Ann. Mag. Nat. Hist.,' ser. 6, vol. ix, p. 209.

[2] 1879, Wachsmuth and Springer, 'Proc. Acad. Nat. Sci. Philad.,' p. 338.

## PLATE XVIII.

*All the figures in this Plate are from specimens from Lummaton in my Collection except when otherwise stated.*

CRANIA PROAVIA, *Goldfuss?* (Page 160.)

FIG.

1. A small specimen, imperfect above, attached to the hinge of a specimen of *P. brevirostris*, × 7. 1 *a*, side view.

POLYPORA POPULATA, n. sp. (Page 174.)

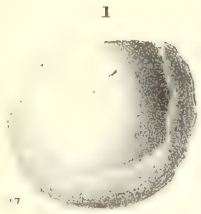
2. A large specimen, partly a natural section and partly retaining the poriferous internal surface. 2 *a*, one fenestrule, × 10. Lummaton? Torquay Museum.
3. Another specimen, showing the external surface.
4. Another specimen, × 10, showing the external surface.

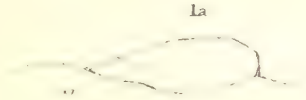
POLYPORA PAGANA, n. sp. (Page 176.)

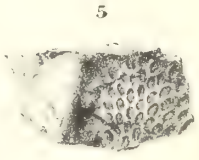
5. A small specimen, chiefly a section, but retaining the inner surface on the upper part. 5 *a*, a fenestrule, × 10.

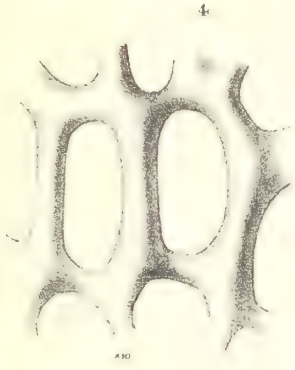
FENESTELLA FANATA, n. sp. (Page 165.)

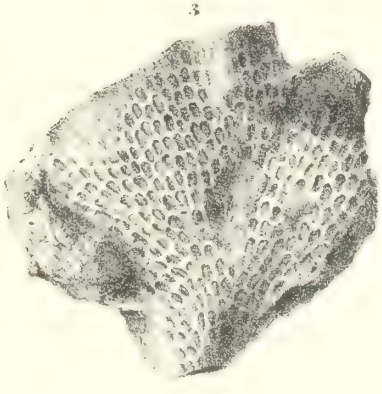
6. Specimen of inner surface.
7. Another specimen, showing the ribbed external face, × 10.
8. A similar specimen with rather larger fenestrules, × 10. Lummaton. Woodwardian Museum.
9. Specimen of the internal face, showing an additional line of pores in one branch just before divarication, × 10.
10. Another specimen, showing a peculiar mode of multiplication of branches which is occasionally seen, × 10.

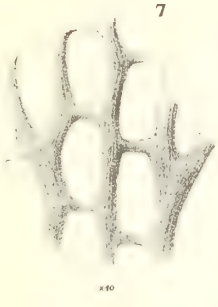


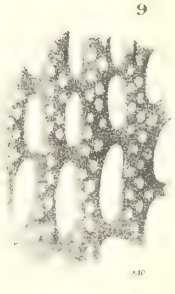


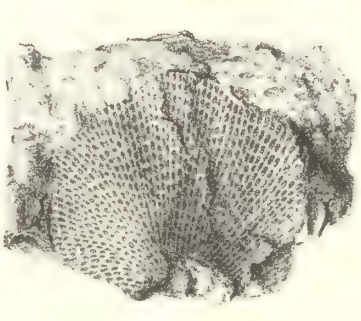



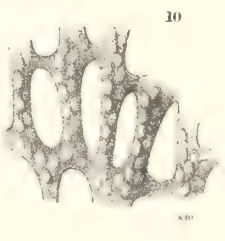





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# PLATE XIX.

*All the figures in this Plate are from specimens from Lummaton in my Collection except when otherwise stated.*

POLYPORA POPULATA, n. sp. (Page 174.)

FIG.

1. Transparent section, showing the arrangement of the cells and their invasion of the dissepiments, × 10. 1 *a*, another part of the same section, showing the vertical arrangement of the cells and the cell mouths, × 10.

FENESTELLA DELTA, n. sp. (Page 169.)

2. Specimen showing keeled branches, angular in section, with five cells to a fenestrule × 10.

FENESTELLA FANATA, n. sp. (Page 165.)

3. Transparent section, showing the shape of the cells with long narrow mouths, and about four cells to a fenestrule, × 10.
4. Vertical section, possibly of this species, × 10.

FENESTELLA ARTHRITICA, *Phillips*. (Page 170.)

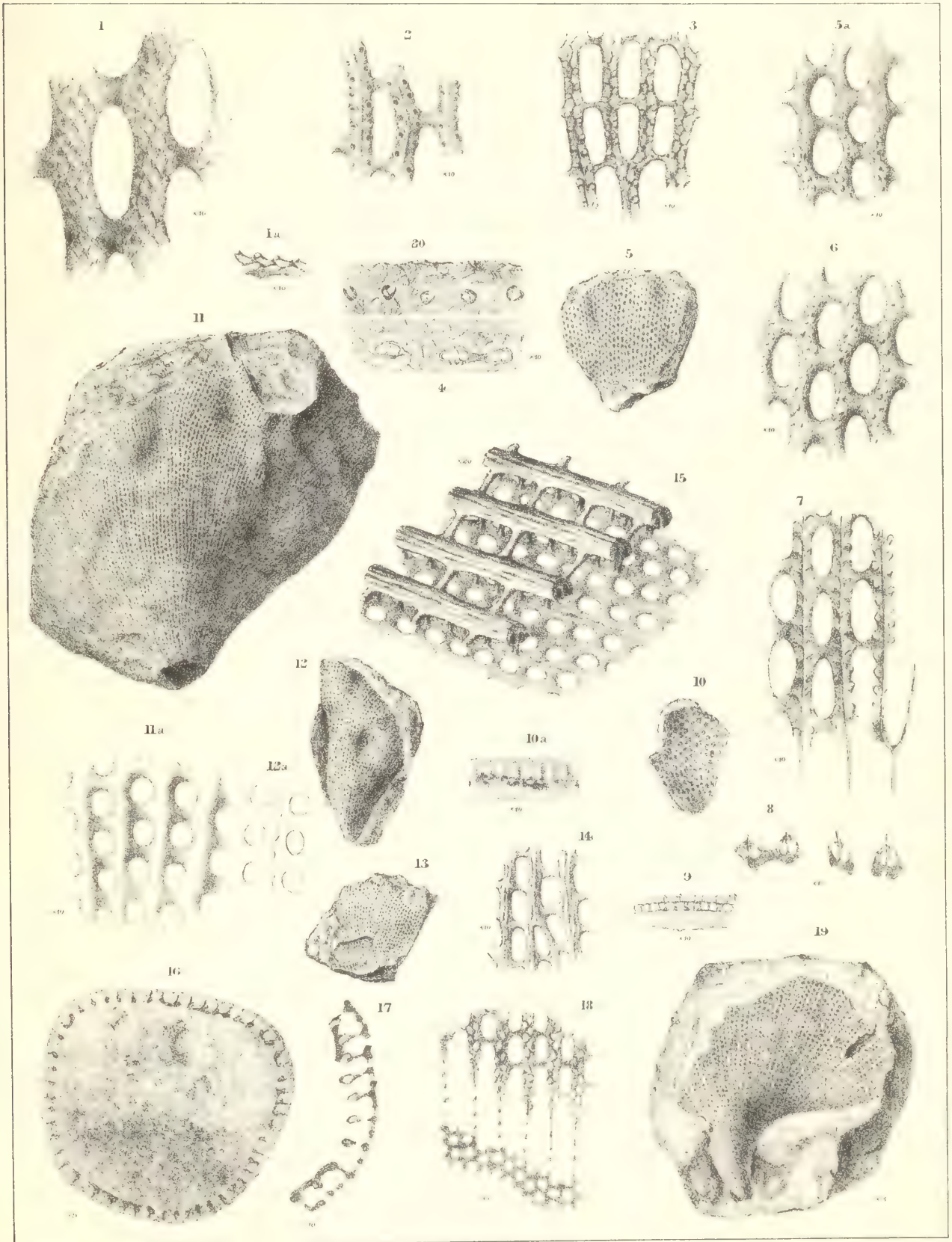
5. Portion of a flat frond, natural size, somewhat worn. 5 *a*, a small portion of the same, × 10, showing remains of the granulations and the longitudinal striation.
6. Another specimen, with the surface perfectly preserved, showing the branches covered with granulations, × 10.
7. Transparent section, showing the oval fenestrules, the cells, and the elevated central keel, × 10.
8. Transparent section taken across a branch, showing the central keel and the shape and mouths of the cells, × 10.
9. Transparent section taken along a branch, showing nodules, × 10.
10. A fragment of a worn frond probably of this species, apparently showing the inner or unkeeled surface. 10 *a*, natural section along a branch, × 10, showing the supports of the keel.

FENESTELLA SUBRECTANGULARIS, *Sandberger*. (Page 173.)

11. Large specimen, natural size. 11 *a*, portion of exterior surface, × 10, showing the elevated rounded branches and the frequently parallel arrangement of the fenestrules. Wolborough. Vicary Collection.
12. Another specimen of an apparently conical specimen having the same characters. 12 *a*, small portion enlarged, showing two cells only to a fenestrule.

HEMITRYPA OCULATA, *Phillips*. (Page 179.)

13. Fragment of a frond of natural size, showing the inward surface except in a small portion, which is broken away, and exposes the outer surface.
14. Small portion of the inward surface, showing its striation, × 10.
15. Idealised view of a specimen, × 20, showing the fenestrules, the position of the cells, the supports of the external guard, and the arrangement of that guard.
16. Section across a specimen, × 5, showing its conical form, the arrangement of the cell-bearing branches and the supports of the guard.
17. Another specimen, × 10, showing in addition the section of the external guard and the alternating arrangement of the cells.
18. Transverse transparent section of another specimen, showing the arrangement of the cells, the pillars, and the external guard.
19. A small specimen, × 3, showing its general shape and the arrangement of the guard.
20. Transparent section, probably of a specimen of this species, which has lost the guard, × 10.

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## PLATE XX.

*All the figures in the Plate are from specimens from Lummaton in my Collection except where otherwise stated.*

ISOTRYPA ? GREGORII, n. sp. (Page 181.)

FIG.

1. Small specimen, showing the external surface and the general conical form.
2. Portion of another specimen, showing the internal surface and the indistinct cast of the exterior. 2 *a*, section of another part of the same specimen, taken across the branches, showing its conical form and the relation between the cell-branches and the guard, × 5. 2 *b*, a portion of the same, × 10, showing the arrangement of the cells, the expanding pillars, and the cellular tissue. 2 *c*, section of another portion taken along the branch, showing apparently the bulging sides of the cell-chambers and the thickened expanding guard of the external side. 2 *d*, an oblique transverse section showing the keels and the tissue. 2 *e*, a portion of the same section, × 25, showing the supplementary cells on the keel.

FENESTELLA, sp. (Page 172.)

3. A small fusiform specimen, × 2. 3 *a*, portion enlarged, showing the cells opening on the external side, and about four cells to a fenestrule. Lummaton. Woodwardian Museum.

DIPLOPORA PRISTINA, n. sp. (Page 182.)

4. A fragmentary branch having six cells on one side without any signs of dissepiments, × 20.

SEPTOPORA, sp. (Page 183.)

5. Specimen showing the inequality of the branches. 5 *a*, portion, × 10, with worn surface. Torquay Museum.

PTILOPORA ? sp. (Page 184.)

6. A specimen in which the lateral branches are almost destroyed, × 5. Lummaton. Champernowne Collection.

PENNIRETIPORA ? sp. (Page 185.)

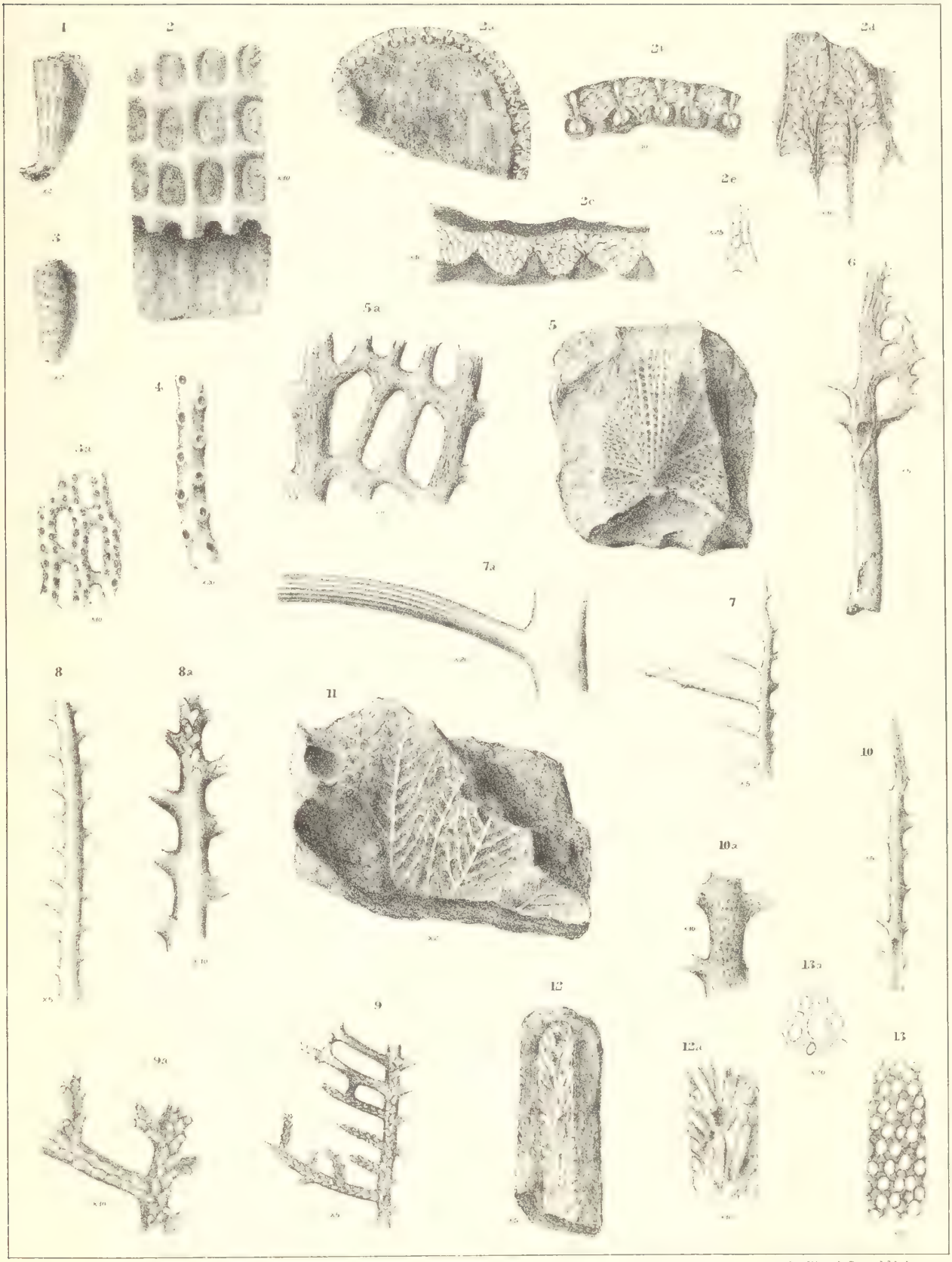
7. Specimen with apparently free lateral branches, × 5. 7 *a*, upper branch, × 20, to show the longitudinal striation. Lummaton. Woodwardian Museum.
8. Specimen, × 5, showing the setting of the subsidiary branches. 8 *a*, portion of the same, × 10, showing the arrangement of the cells.
10. Another specimen, × 5. 10 *a*, a portion of the same, × 10, showing the minute ornament.

RAMIPORA, sp. (Page 187.)

9. Transparent section of a specimen showing the main and subsidiary branches, × 5. 9 *a*, portion of the same section, × 10, showing the shape and arrangement of the cells.
11. Specimen showing the major and minor branches, × 2. Lummaton. Torquay Museum.

BATOSTOMELLA OOMORPHA, n. sp. (Page 188.)

12. Natural section of a specimen, × 5. 12 *a*, the same, × 10, showing the cells.
13. Transparent section, × 10. 13 *a*, a portion of the same, × 20, showing the mesopores, but not the acanthopores which are visible in other parts of the specimen.

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# PLATE XXI.

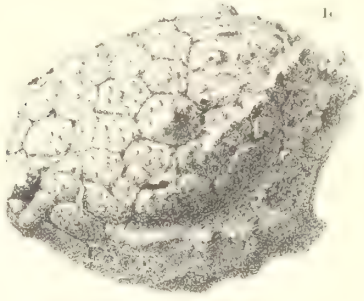
HEXACRINUS INTERSCAPULARIS, *Phillips*, sp. (Page 190.)

FIG.

1. Phillips's original type, side view showing the anal plates. 1 *a*, and 1 *b*, front and rear views, indistinctly showing the primibrachs. 1 *c*, ventral view. 1 *d*, dorsal view, showing the very small comparative size of the column. (The anal, which is the lower plate to the left, is here drawn slightly too wide.) Wolborough. Museum of Practical Geology.
2. A large distorted specimen, with an extremely elevated tegmen. Wolborough. Museum of Practical Geology.
3. Another specimen, with a very shallow cup and unusually fine and thick corrugated ornament; showing the anal plates. 3 *a*, dorsal view, showing that the column was comparatively large. Wolborough. Vicary Collection.
4. An unusually large example, with crowded ornament showing two radials. 4 *a*, dorsal view. Wolborough. Vicary Collection.

1

1a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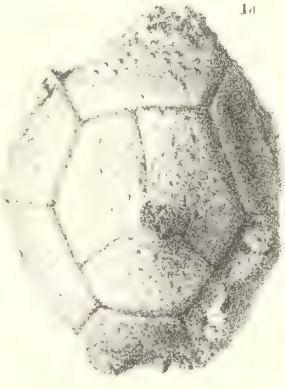
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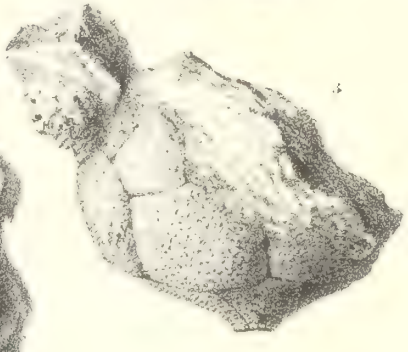
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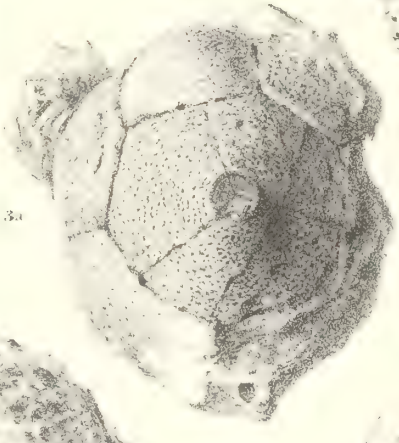
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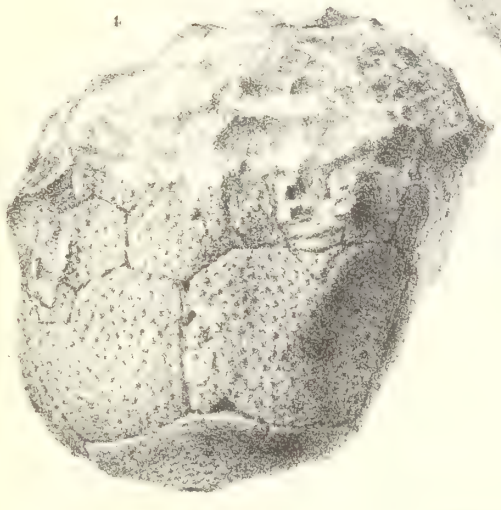
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4a

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# PLATE XXII.

HEXACRINUS INTERSCAPULARIS, *Phillips*, sp. (Page 190.)

FIG.

1. A rather worn specimen, showing the anterior, left anterior, and left posterior radials, with suture-lines excavated either naturally or in cleaning. 1 *a*, ventral view (anal side lowest). Wolborough. Vicary Collection.
2. Left posterior view of a specimen, with very depressed dome (*H. depressus*, Austin), with deep and wide suture-lines, caused probably by the decay of the surface. 2 *a*, ventral view, showing the arrangement of the plates of the tegmen (anal side to the left below). Wolborough. Museum of Practical Geology.

HEXACRINUS MACROTATUS, *Austin*. (Page 192.)

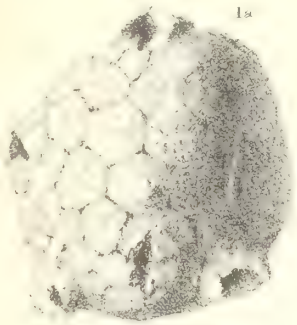
3. Right anterior view of a specimen with very much obliterated surface. 3 *a*, ventral view, showing the position of the arms, and indistinctly the plates of the tegmen. (Anal side to the right below.) Wolborough. Torquay Museum.
4. Side view of another specimen, showing ornament though rather worn. 4 *a*, dorsal view. Wolborough. Vicary Collection.
5. Dorsal view of a smaller specimen, showing the first joint of the column. Lummaton ? Torquay Museum.
6. Posterior view of Austin's type specimen, in which the surface ornament is totally obliterated. The cup is a good deal compressed, the dimensions of the side view being almost the same as those of fig. 3. Wolborough. Museum of Practical Geology.
7. Posterior view of another compressed specimen, with obliterated surface, showing radial and anal plates. Wolborough. Torquay Museum.
8. Side view of a worn specimen, showing the large radial and one of the secundibrachs (probably the specimen from which Austin's figure of *H. macrotatus* (3 *d*), and perhaps also Phillips's figure of *H. tuberculatus* were taken, but, if so, much injured since they were drawn. Wolborough. Museum of Practical Geology.

HEXACRINUS PERARMATUS, *Whidborne*. (Page 194.)

9. A specimen showing the ornamentation; the anal plate seen to the right. 9 *a*, ventral view, showing plates. 9 *b*, anal plates. 9 *c*, right anterior radial, supporting the axillary plate and large secundibrachs. Wolborough. Vicary Collection.
10. Another specimen, showing anal plate, defective above. Wolborough. Museum of Practical Geology.

HEXACRINUS ORNATUS, *Goldfuss*, sp. (Page 195.)

11. Side view of a calyx, defective above. 11 *a*, dorsal view. Wolborough. Museum.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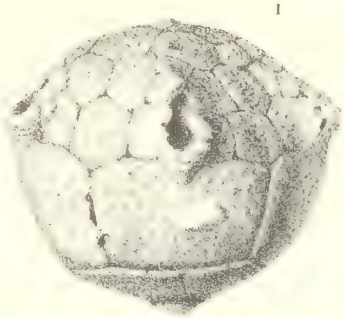
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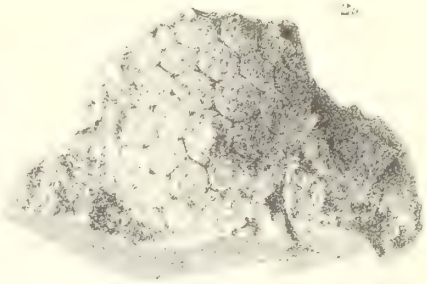
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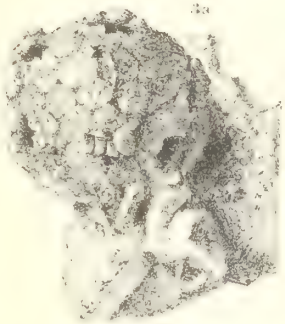
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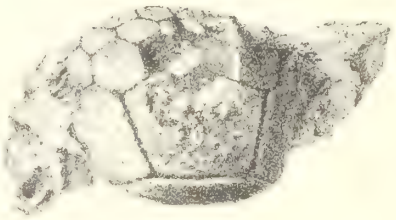
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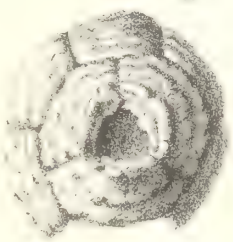
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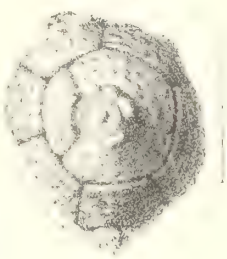
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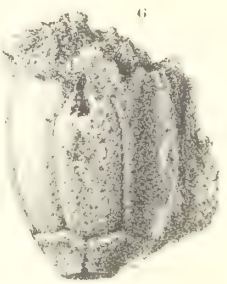
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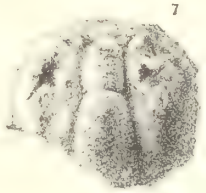
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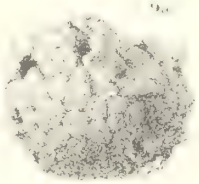
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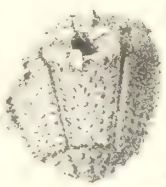
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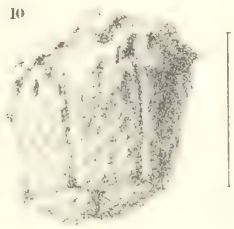
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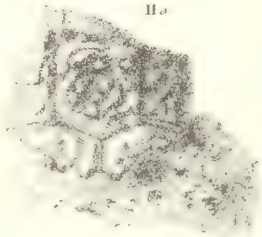
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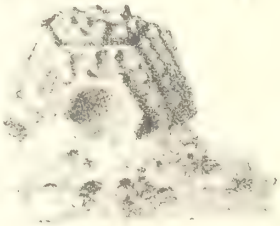
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## PLATE XXIII.

HEXACRINUS MICROGLYPHICUS, *Whidborne*. (Page 196.)

FIG.

1. A well-preserved calyx, showing the anal plate. 1 *a*, dorsal view. Wolborough. Vicary Collection.
2. A large but very defective specimen, with the surface obliterated. 2 *a*, dorsal view. Wolborough. Vicary Collection.

HEXACRINUS? ABERRANS, *Whidborne*. (Page 199.)

3. A large but very defective specimen. Lummaton. My Collection.

HEXACRINUS VICARII, *Whidborne*. (Page 197.)

4. An imperfect specimen, preserving the ornament. 4 *a*, dorsal view. Wolborough. Museum of Practical Geology.
5. Another imperfect specimen. 5 *a*, dorsal view. Wolborough. Museum of Practical Geology.

HEXACRINUS QUINTANGULUS, *Whidborne*. (Page 198.)

6. Austin's specimen figured by him as *H. pentangularis*, Miller, showing the first secundibrach (?). 6 *a*, dorsal view. 6 *b*, outline of small brachials. Wolborough. Museum of Practical Geology.
7. A small but rather more perfect calyx, showing first joint of the column, anal, and some of the brachials. Wolborough. Vicary Collection.

RHIPIDOCRINUS CRENATUS, *Goldfuss*, sp.? (Page 203.)

8. A very indistinct specimen. 8 *a*, dorsal view. Loc.? Torquay Museum.

HAPLOCRINUS DECIPIENS, *Whidborne*. (Page 205.)

9. A small specimen, showing a bisected radial to the right, and the longitudinal prominence of the centre of the radials ending in the large angular articular facets, × 6. 9 *a*, ventral view. Lummaton. My Collection.

STORTHINGOCRINUS FRITILLUS, *Müller*, sp. (Page 206.)

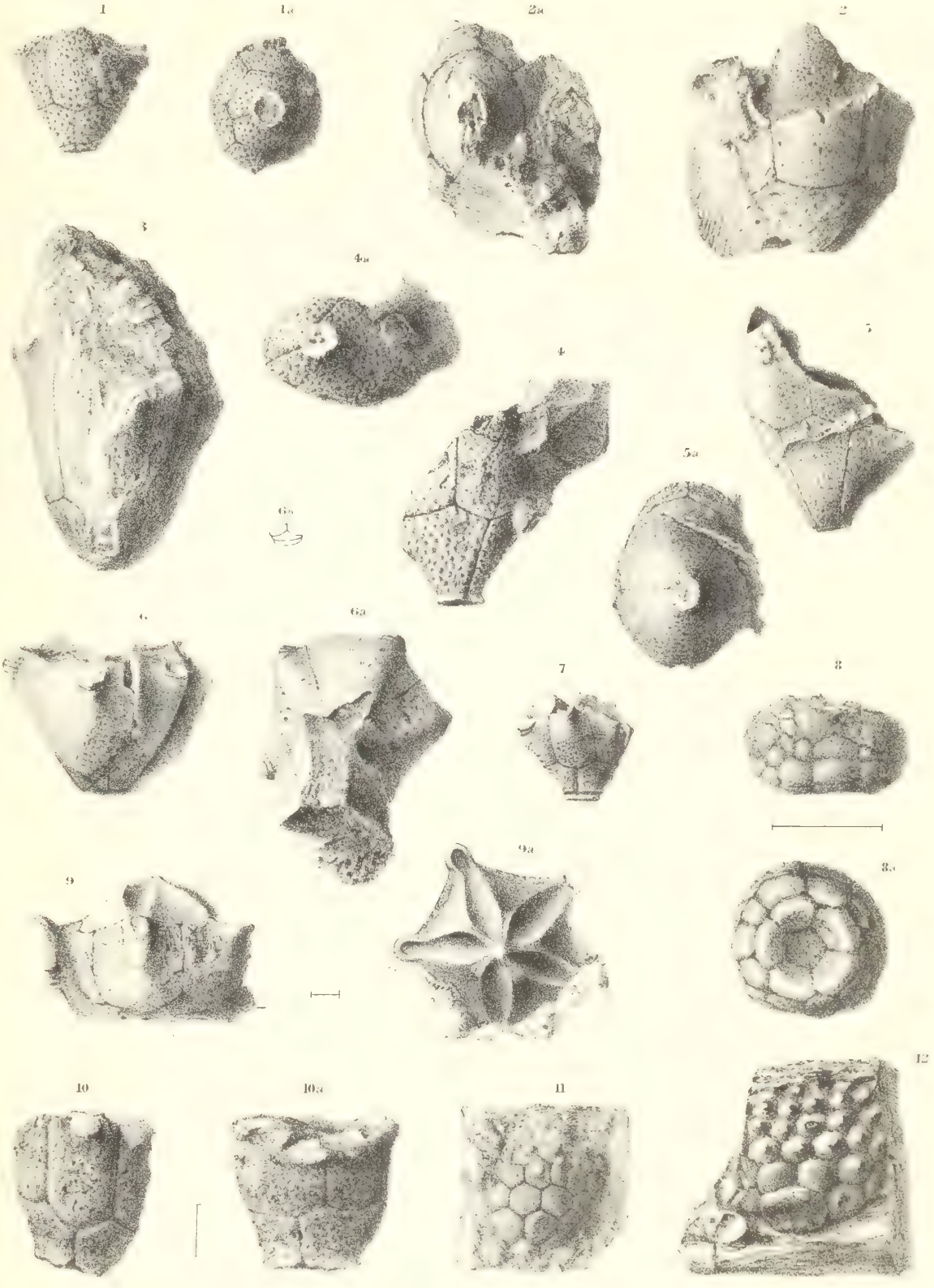
10. A small specimen. 10 *a*, another view. Wolborough. Museum of Practical Geology.

THYLACOCRINUS? sp. (Page 202.)

11. A specimen showing the part of a calyx embedded in matrix. Lummaton. My Collection.

MELOCRINUS STELLARIS, *F. Römer*, sp. (Page 200.)

12. A specimen showing a large part of the calyx. Torquay Beach. Grenfell Collection.

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# PLATE XXIV.

MELOCRINUS HIEROGLYPHICUS, *Goldfuss?* (Page 201.)

FIG.

1. A specimen which is nearly perfect though crushed and confused by fractures, with remains of ornament which are too indistinct to be shown. 1 *a*, ventral view. 1 *b*, dorsal view. Lummaton. Torquay Museum.

*Sedis incertæ.* (Page 212.)

2. A portion of the large anal tube of a Crinoid? 2 *a*, a few of the plates, × 4. Lummaton. Torquay Museum.

CUPRESSOCRINUS SCHLOTHEIMII, *Steininger*, sp. (Page 209.)

3. A dorsal cup showing the basal and radial plates. 3 *a*, dorsal view showing the small size of the infra-basal ring. 3 *b*, upper view. Wolborough. Champernowne Collection.

5. A specimen of one of the arms seen from within, × $\frac{3}{2}$. 5 *a*, the same specimen seen from below. Lummaton. My Collection.

CUPRESSOCRINUS CRASSUS, *Goldfuss*. (Page 207.)

4. A defective dorsal cup. 4 *a*, dorsal view, the centre plate of which has been completed from another fragmentary specimen. Wolborough. Museum of Practical Geology.

RHODOCRINUS, sp. (Page 204.)

6. Basal or radial spine, × 3. 6 *a*, another view. Wolborough. Museum of Practical Geology.

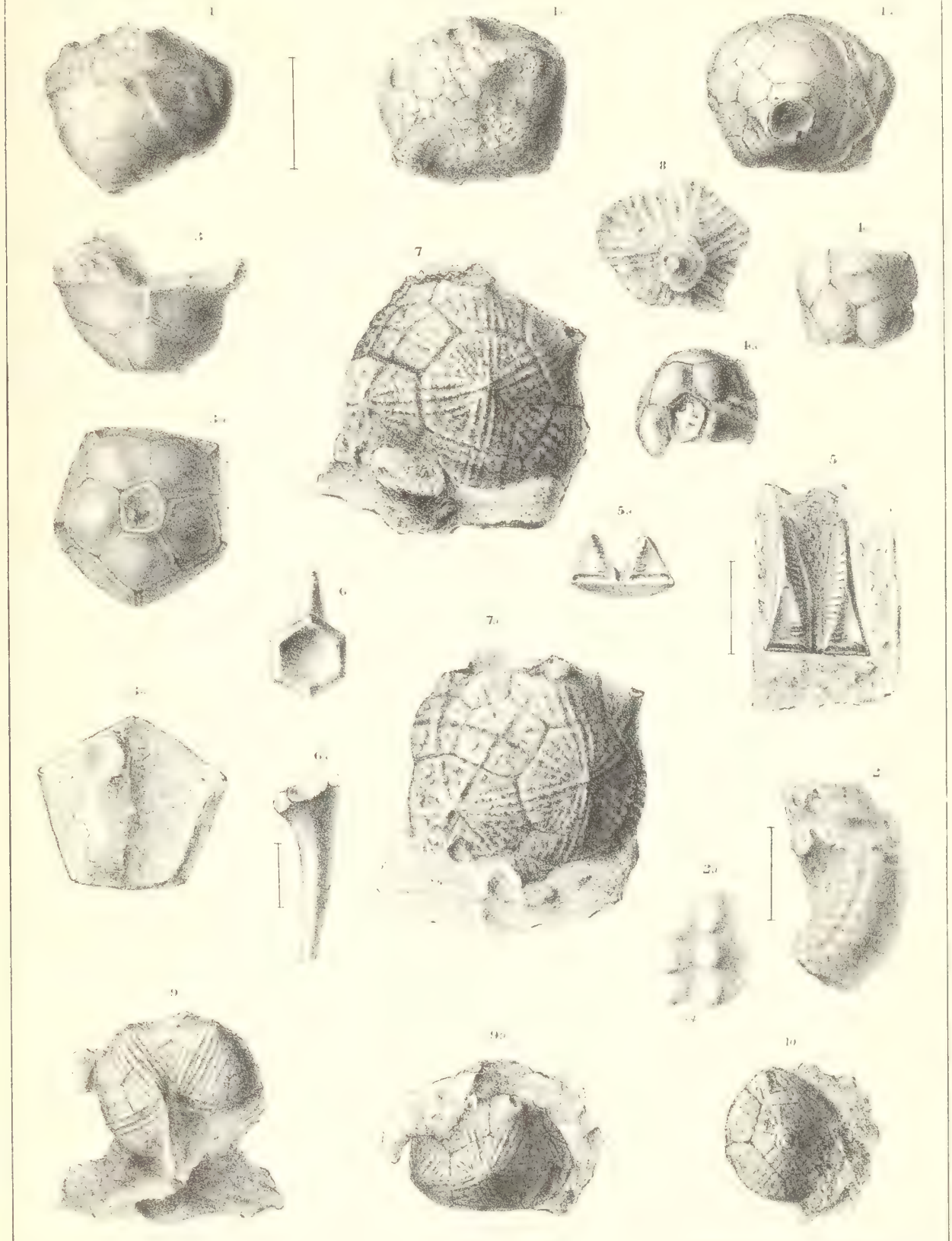
SPILÆROCRINUS GEOMETRICUS, *Goldfuss*, sp. (Page 211.)

7. A very large though imperfect specimen. 7 *a*, the same seen from a rather different aspect, showing the anal plates. Wolborough. Torquay Museum.

8. The imperfect infra-basal circlet of a still larger calyx. Wolborough. Museum of Practical Geology.

9. Another specimen, basal view. 9 *a*, lateral view, showing the contraction of the ventral side. Wolborough. Torquay Museum.

10. Smaller specimen, showing the arrangement of the plates. Wolborough. My Collection.



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